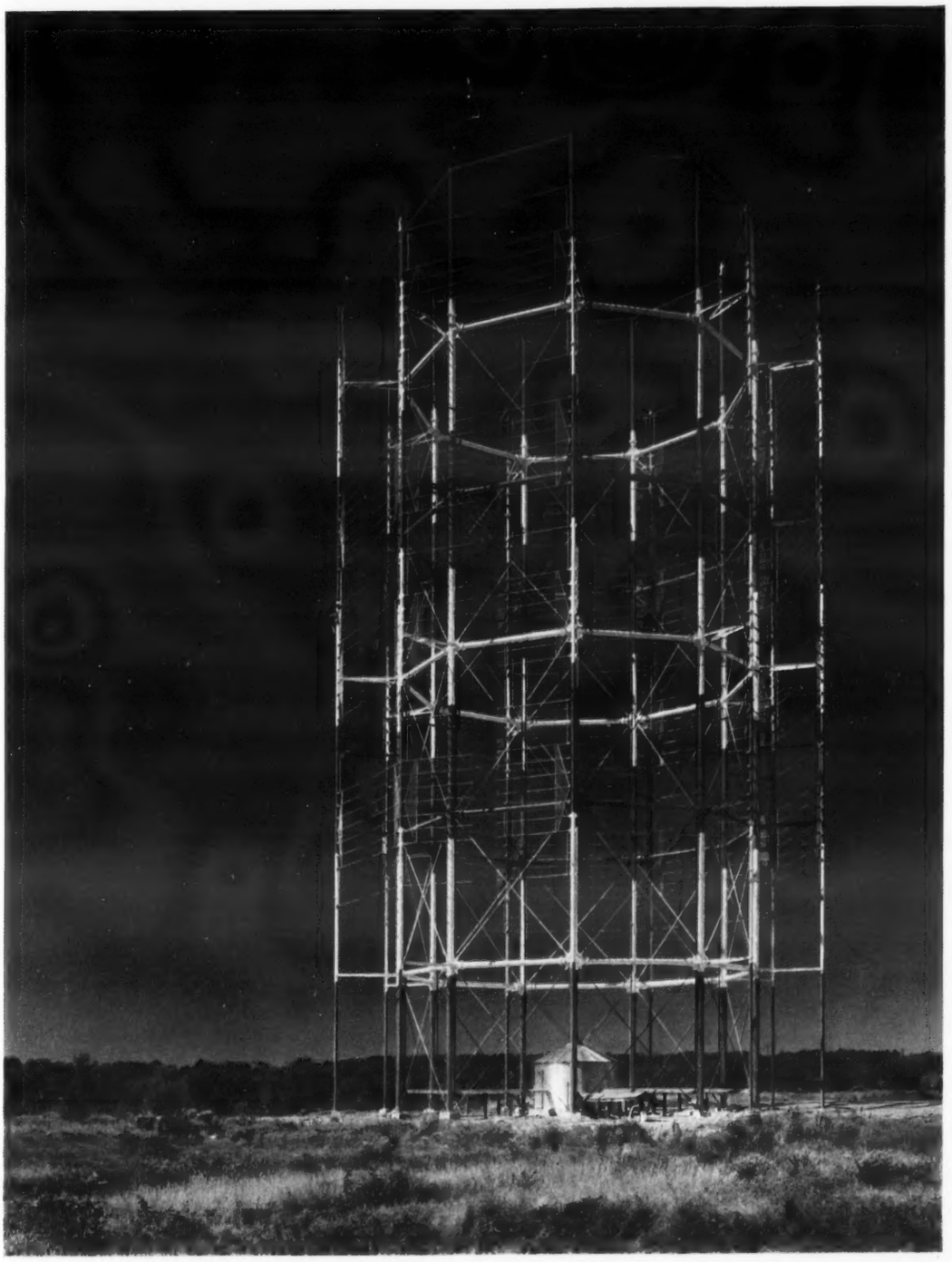
INTERAVIA

World Review of Aviation and Astronautics
with Electronics Supplement



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Volume XV

INTERAVIA

April 1960

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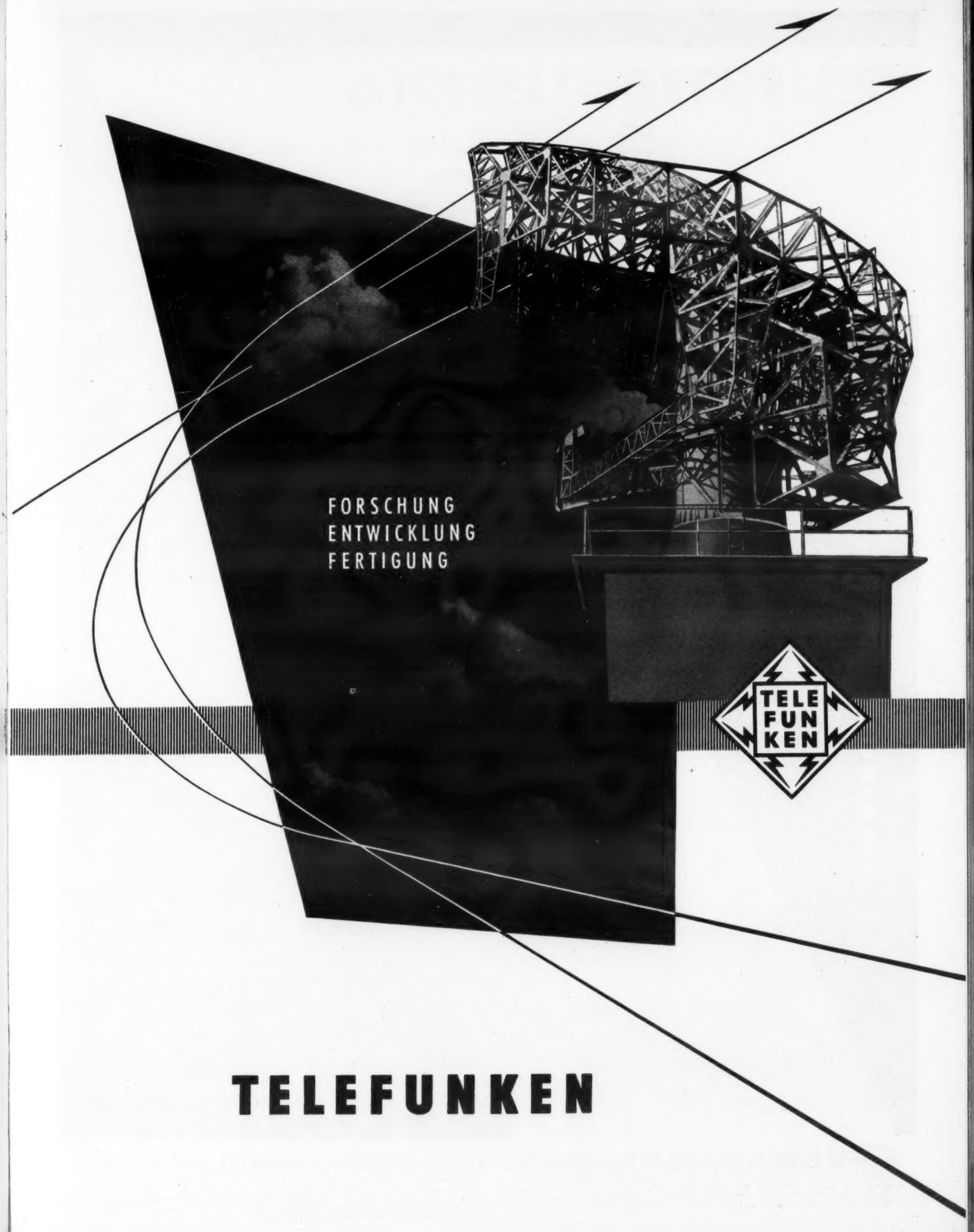

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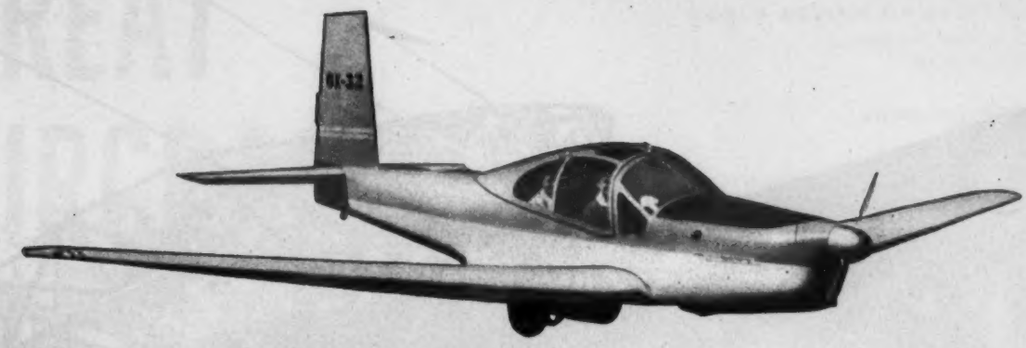

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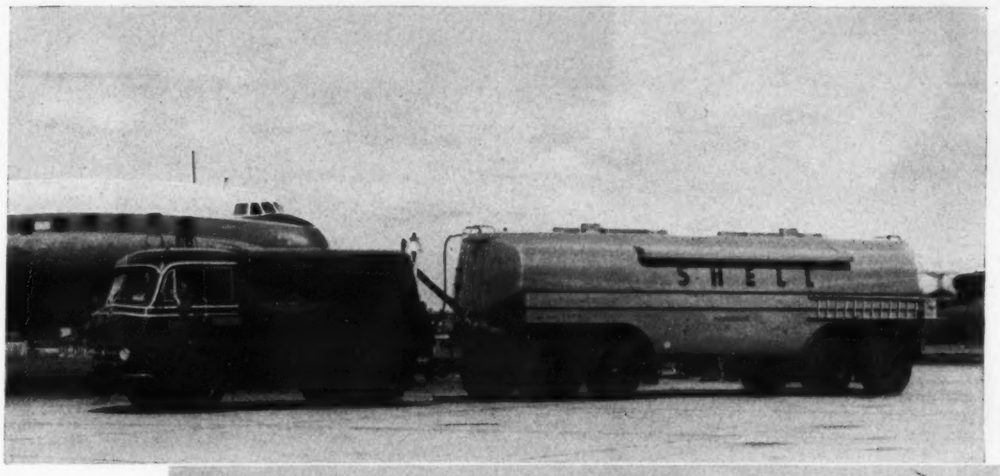

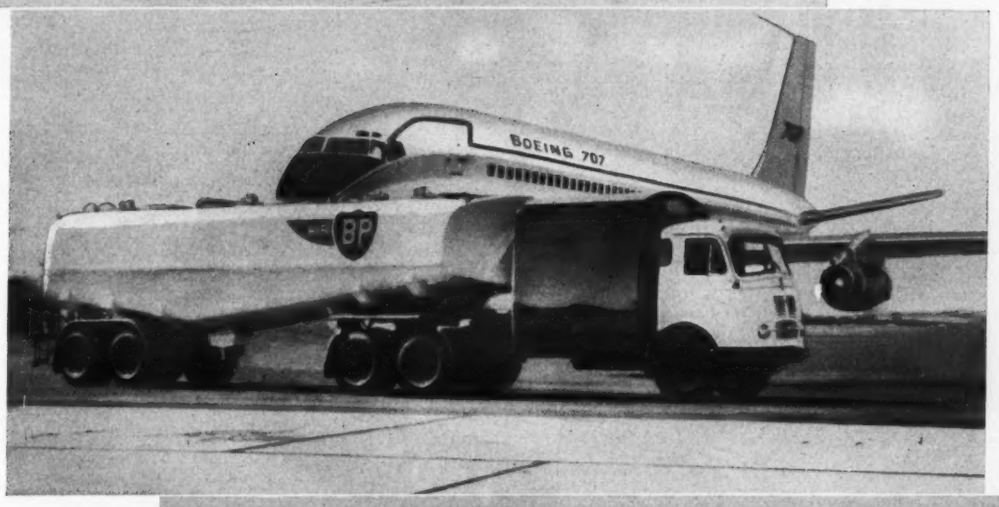

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The new Boeing 720 offers airlines the lowest seat-mile cost of any jetliner

The newest jetliner in the world — the Boeing 720 — is pictured above during a recent test flight. Delivery of the first 720 is scheduled for this spring. To date, forty-six Boeing 720s have been ordered by leading world airlines.

The new 720 is designed to operate efficiently and profitably over short-to-medium range routes. The 720 cruises at speeds in excess of 600 miles an hour, and has the lowest seat-mile cost of any jetliner. In addition, the 720 can operate more economically from shorter fields than any other jetliner. Seating capacity ranges from 80 to 150 passengers, allowing airlines unusual flexibility in seating arrangements.

As demonstrated by Boeing jets already in service, the 720 will bring airlines unprecedented passenger appeal and high daily utilization.

Boeing 707 jets have already flown more than 76,300,000 miles in scheduled operations and have carried more than three million passengers.

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The system has been ordered by The Netherlands Government and the first phase is now on operational test.

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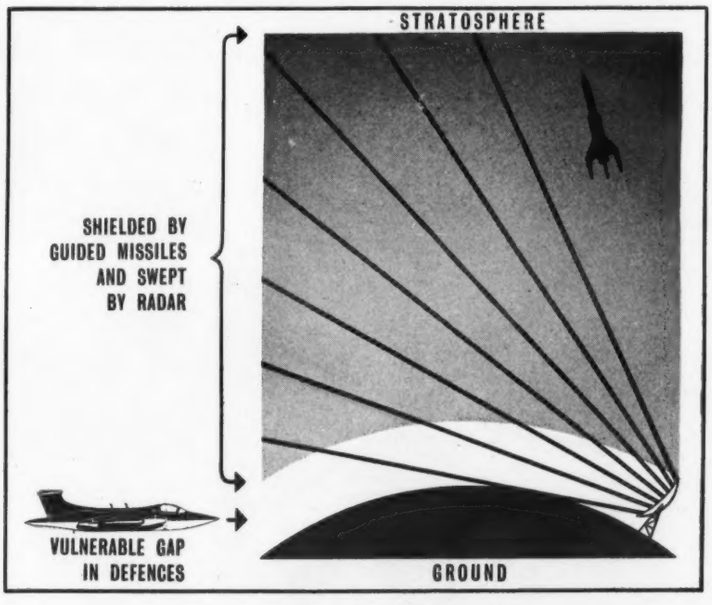

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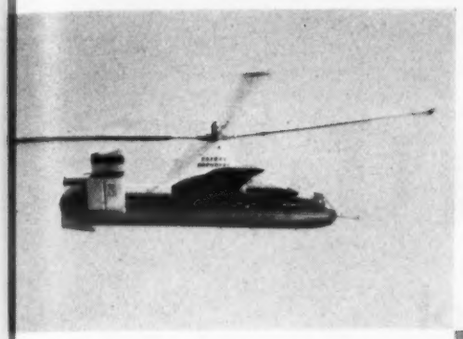

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SIDELOBE SUPPRESSION

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It is well known that there is some uncertainty concerning the technique of sidelobe suppression to be used in the ATC Radar Beacon System. It is also, we believe, well known that Cossor engineers have played leading parts in the development of this system: we feel therefore that it is appropriate that we should state our position in this matter.

Several possible techniques of sidelobe suppression have been proposed, but only two are now being considered internationally. They are the two-pulse system originally agreed by ICAO, which is still the only internationally agreed system, and a three-pulse system which has recently been proposed by the U.S. Federal Aviation Agency (FAA). There are good arguments for and against both systems but we do not propose to recapitulate them all here. One argument must be mentioned, however; it is that it is very difficult to design an airborne transponder to work with the ICAO two-pulse system. So it is; but we have done it.

We do not wish to take sides in the discussion. We do not wish to press for the retention of the ICAO system simply because we can supply transponders and ground interrogators which will meet the requirement. What we do want to see is the earliest possible international adoption of the system as a whole. To encourage this we are prepared to supply transponders incorporating the internationally agreed two-pulse method of sidelobe suppression and to undertake at the same time that for a fixed price we will modify them to work in addition with the FAA three-pulse system if that system is internationally adopted.

We realise that this is a somewhat unusual offer, but we also realise that it may take several months to reach a final settlement of the sidelobe suppression question.

In the meanwhile we wish to do what we can to assist in the furthering of the ATC Radar Beacon system which is of such great importance to civil aviation. Aircraft equipped with transponders can obtain service now from many interrogators, and the more beacon-equipped aircraft there are in service the better will be the chances of obtaining the operational experience necessary to determine the best way of exploiting the system. Clearly, however, no airline wishes to buy equipment which may have to be replaced at an unknown cost as a result of a change of international agreement. We believe that the terms of the offer we are now making are sufficiently attractive to dispose of this fear.

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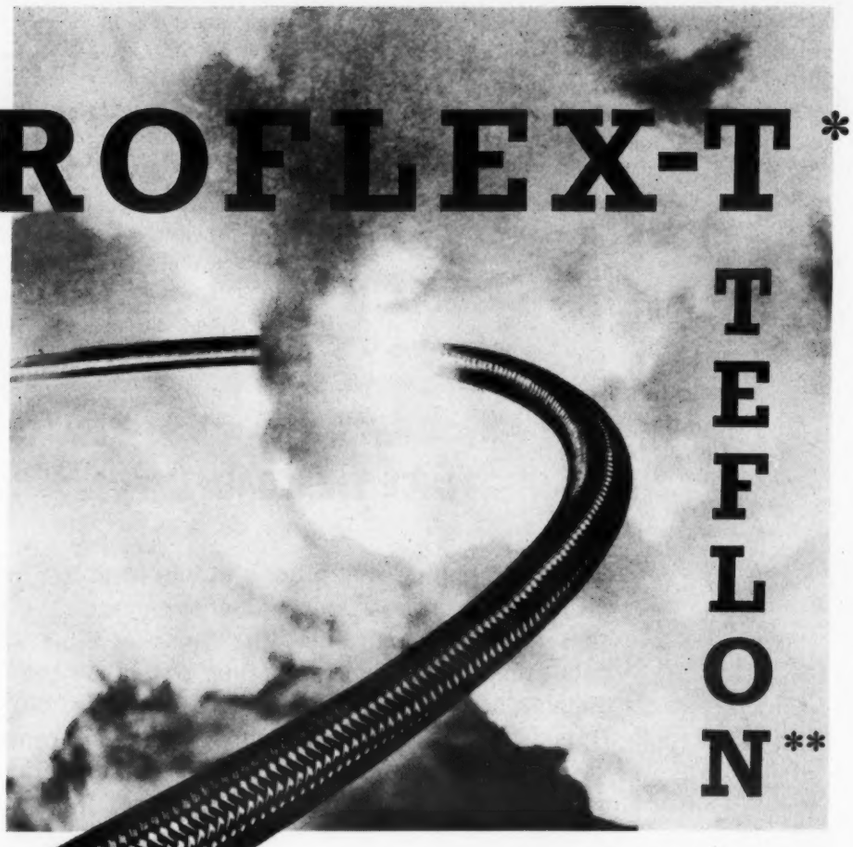

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INTERAVIA AIR LETTER reports...*

The IATA Special Traffic Conference in Paris ended in mid-March with practically full agreement on all points outstanding from last year's Honolulu Conference. In general terms, the outcome is firstly an overall reduction in the lowest fares and secondly the operation of only two classes of travel, i.e., either first and economy or first and tourist, depending on the route concerned. In brief, the most important decisions affect the routes listed below :

North Atlantic : Introduction of a round-trip excursion fare London-New York, valid for 17 days, of $350 on jet aircraft or $320 on conventional aircraft ; this fare will be available between October 1st, 1960 and March 31st, 1961. The introduction of a new $500 one-way fare London-New York for the highest class, which will in future be designated "first class" on jets and "first class with sleeper seats" on propeller aircraft. The designation "de luxe class" will be dropped completely.

A fare of $440 has also been agreed for propeller aircraft with normal first class seating. With effect from July 1st, only two classes will be offered on the North Atlantic, first and economy. The basic one-way economy fare New York-London will be $254. Up to October 1st, 1960 a reduction of $20 one way, or $36 round trip will be applied to travel on piston-engine aircraft; between October 1st and March 31st these reductions will be $30 and $54 respectively.

Tariffs between New York and other European capitals and to the Middle East will be modified correspondingly. "Family" rates will continue to be offered in two classes during the off-peak season.

South Atlantic : On the South and Central Atlantic routes the current rates will be maintained up to October 1st, 1960 with no differential for fares between the jets and propeller aircraft equipped with sleeper seats. A reduced first-class fare will be applied to propeller aircraft with standard seating. From October 1st an economy class will be introduced at rates equivalent to tourist class minus 16 percent (approximately $30 less on a one-way trip).

Far East and Africa : On services between Europe and the Far East, fares—with no jet differential—will be slightly increased for first class travel, and reduced by 6 to 10 percent for tourist class with effect from October 1st. The same applies to services between Europe and Africa, with a 10 percent reduction for the tourist class. Fares between the Far East and Australia remain unchanged.

Excursion fares will be adopted between Europe, India, Pakistan, Ceylon and Nepal, offering a 22 percent reduction for groups of six or more people travelling together. Similar rates will be offered between Britain, Northern Ireland and South Africa, where the reduction will be 16 percent on the tourist rate with a validity of 90 days.

---

* Interavia Air Letter is a daily international news digest published in English, French ("Courrier Aérien") and German ("Luft-Post"). All rights reserved.

Braniff International Airways announces the signing of a letter of intent for the purchase of three Boeing 720s, powered by Pratt & Whitney JT3C-7s, for delivery in February, April and September, 1961. Braniff has also taken an option on an additional four Boeing 720s for delivery from May, 1962 onwards. Braniff ordered five Boeing 707-227s in December, 1955. The Braniff letter of intent brings Boeing's order-book for the 707 series to a total 210 aircraft.

●

El Al Israel Airlines has decided to buy the Boeing 707 (with *Conway* engines) and is to take an option on two aircraft. The decision has the backing of both the Ministry of Transport and the Treasury. A leading El Al personality in Tel Aviv has indicated that Boeing would deliver the two aircraft fourteen months from receipt of a firm order. Treasury circles say that the cost of the two Boeing 707-420s would be about $18 million.

●

Olympic Airways has ordered a third *Comet 4B*, valued at about £1 million, from de Havilland Aircraft, bringing the *Comet* order-book up to a total of 47 aircraft.

●

Trans Arabia Airways, a Lebanese carrier, has placed an order with Hawker Siddeley Aviation for two Armstrong Whitworth AW.650 *Argosy* aircraft with an option on a third; together with spares, the initial contract is valued at about £1.1 million. Deliveries will take place later this year. Trans Arabia operates a fleet of DC-6 and DC-4 aircraft on a route network throughout the Middle East, and is the first carrier to order the *Argosy*.

●

British European Airways is to lease three *Argosy* aircraft from Armstrong Whitworth for freight work. If operations are successful an order is likely to follow.

●

The Swissair summer 1960 timetable includes the following planned *Caravelle* services : From May 21st three services daily between Zurich and London (two daytime, and the third at night depending on Government approval), with connections from Geneva. From July 15th one flight daily Geneva/Zurich-Düsseldorf-Stockholm, with an additional three night services weekly (Wednesday, Thursday and Saturday) via Copenhagen. From July 16th Middle East routes will be served with one flight each day to Athens, three flights weekly (Monday, Wednesday and Saturday) to Tel Aviv, and twice weekly (Friday and Saturday) to Istanbul, Ankara and Cairo. From August 16th the Caravelle will be operated four times weekly (Tuesday, Thursday, Saturday and Sunday) on the route Geneva-Madrid-Lisbon, and six times weekly (except Sundays) Geneva-Zurich-Vienna. Swissair's four *Caravelles* are scheduled for delivery on April 27th, June 20th, June 30th and July 20th.

●

Air France inaugurated twice-weekly (Monday and Friday) scheduled service Paris-Montreal-Los Angeles on April 4th with Boeing 707 *Intercontinentals*. Departure Paris-Orly 17:30, arrive Los Angeles 23:00 (local times). Air France says that Los Angeles will be the 216th point to be served on the carrier's route network. Flight time Paris-Los Angeles will be 13 hours 30 minutes. The Paris-Montreal-Los Angeles route is part of the round-the-world network to be operated by Air France and TAI from May onwards.

●

Alitalia launched its first service to Eastern Europe on April 5th, introducing twice-weekly (Tuesday and Thursday) *Viscount* flights Rome-Prague ; this operation will probably be extended on to Warsaw in 1961. Alitalia's new four-times-weekly (Monday, Wednesday, Friday and Sunday) service Rome-Milan-Amsterdam also came into operation at the beginning of April.

●

Paris-Orly regional control centre has placed in service a new surveillance radar constructed by CSF. The Type CR3 long-range surveillance radar consists of a) 2 ER 410 CL-band radars of 2 megawatts peak power operating in frequency diversity (frequency spacing 30 Mc/s) ; b) an MH 206 frequency mixer ; c) a DC 204 C synchronizer unit ; d) two MA 372 fixed echo suppressors consisting of two TCM 13 memory tubes in cascade ; e) a full coverage AT 417 radar head, switchable for horizontal or circular polarization, giving a gain of 34 db and rotating at 6 rpm.

The minimum range of the installation in the worst conditions is 125 miles, and the system fully complies with ICAO recommendations. CSF is constructing twelve L-band radars with a peak power of 2 megawatts, working on the frequency diversity system. These are intended for the French regional control centres of Orly, Marseilles, Bordeaux and Lyon, and for Orly and Le Bourget airports.

●

The Marconi Type S.264A/H surveillance radar for Rome-Fiumicino Airport is being built at the Genoa works of Marconi Italiana SpA, subsidiary of Marconi's Wireless Telegraph Co. Ltd. Marconi Italiana will also install the equipment at Fiumicino Airport. The Italian Government order includes two display systems (comprising 11 display units), a microwave radar link and ancillary equipment. The radar head will be generally similar to that at present installed at London Airport, except that the Fiumicino installation is designed to provide additional high coverage. The two display systems will cover short range (maximum 40 miles) and long range (maximum 160 miles) ; they will be installed in different locations and connected via a microwave radar link.

Airspace surveillance in the region of Rome is complicated by the hilly nature of the terrain, which causes unwanted permanent echoes on radar screens. This can be eliminated by the Marconi S.264A/H Moving Target Indicator. A further advantage lies in the 50-cm wavelength, which enables snow and rain clutter to be avoided.

Value of the initial contract, obtained through Marconi Italiana, is approximately £177,000 ($500,000). Marconi's Wireless Telegraph Co. has now booked orders for a total of 29 50-cm radar equipments.

●

The Cunard Steam-Ship Company has agreed in principle to acquire a controlling interest (about 60 percent) in the British independent Eagle group (Eagle Airways and associated companies). The individual Eagle companies will continue to trade under their existing identities but will benefit from Cunard's extensive sales network in Europe, the United States and Canada.

Discussions are now in progress with BOAC regarding a possible future working arrangement between the Corporation and Eagle. Results will depend on whether Eagle is licenced to operate trans-Atlantic services ; the carrier has already applied for a permit to run services between the U.K. and Bermuda. If this is granted, the U.K.-Bermuda services might link up with Eagle's existing scheduled passenger operations between New York, Montreal, Baltimore, Nassau and Miami. In future Cunard will be responsible for financing any expansion of the Eagle fleet, but this will be a fairly long-term operation depending on the licences which Eagle might be able to obtain for trans-Atlantic routes. The Corporation is also exploring possible collaboration with Cunard in an air-sea service to further British interests across the Atlantic.

●

The Federal Aviation Agency's new law requiring the retirement of commercial airline pilots at the age of 60 went into effect on March 15th, following the U.S. District Court in Washington's rejection of a plea against the FAA regulation on March 14th. About 35 U.S. commercial airline pilots over the age of 60 are affected. The new rule also prohibits certification for jet aircraft of pilots over 55 years of age.

●

The U.S. Atomic Energy Commission has announced an $11 million increase for the *Rover* nuclear rocket programme during fiscal 1961. The funds have been diverted from other projects in AEC's fiscal 1961 budget request following the Administration's refusal to grant them. AEC's action followed criticism by the Joint Atomic Energy Committee that Administration reductions in the *Rover* funds requests would mean a postponement of the date when the U.S. could fly a nuclear-powered rocket. The extra $11 million for the project would enable the *Rover* rocket to fly by 1963.

At present the National Aeronautics and Space Administration shares responsibility for *Rover* with AEC. NASA develops the turbopump, nozzle cooling system and hardware, while AEC is responsible for developing the reactor and conducting a ground demonstration of a model of the engine in 1963. AEC officials have put on record their dissatisfaction with the support NASA is giving the programme, and the Joint Atomic Energy Committee has proposed to NASA Director T. Keith Glennan that *Rover* be transferred outright to AEC. Since, however, this would put AEC into the space business along with NASA and the Defense Department, it is unlikely that the suggestion will be considered.

AEC says that if a major effort is undertaken on the *Rover* programme, it will be possible by 1970 to develop and build a nuclear-powered rocket vehicle capable of landing men on the moon and returning them to earth. This claim is flatly dismissed by NASA, which sees no prospect of placing men on the moon until later in the 1970s. NASA believes that a nuclear rocket which can be developed in the present decade will be an outgrowth of the straightforward *Kiwi* type of rocket without much increase in power. Power would be limited to 1,000 to 2,000 thermal megawatts—equivalent to 50,000 to 100,000 pounds thrust. Furthermore, such a rocket would probably have a relatively low power-to-weight ratio—certainly insufficient to make it suitable for a first- or second-stage booster. This would mean that it would have to start from orbit. A nuclear rocket suitable for ground launching would, says NASA, have to have a reactor with a very high power density—100 to 200 megawatts per cubic foot. Despite AEC claims to the contrary, NASA believes this kind of performance is still a long way off.

A. V. Roe has for some time been making studies of twin-jet short-haul airliners, including the Avro 650. The designs have now crystallized into : a) a 50-seater (Avro 761) with two Bristol Siddeley BS.75 (BE.72) ducted fan engines of 7,000 lb thrust each and b) a 65-seater (Avro 771) with Rolls-Royce RB.163 by-pass engines. Both types would operate at high subsonic speeds over stage lengths of 500 n.m., with full payload and reserves. A market survey is being conducted, and if work is put in hand co-operation is likely between Avro and de Havilland, as much of the basic work on the DH.121 could be put to good use. The Avro projects would be directly competitive with the Hunting 107, on which Hunting has already done five years' design work, and of which a mock-up has been constructed.

●

The French Government has placed an order with Société des Ateliers d'Aviation Louis Breguet for the first Breguet 941 blown-flap aircraft. The experimental prototype of this STOL aircraft aroused considerable interest when exhibited at the last Paris Air Show. Breguet General Manager Henri Ziegler has said that there are at present over 300 airfields in France from which the Breguet 941 could operate. As particular instances he cited Nantes, Saint-Etienne, Le Havre, Grenoble, Reims, Limoges and Le Mans, whose airports have only short runways but which are nevertheless important economic centres.

The Breguet 941 can carry a 13,200-lb payload or 50 passengers over stages of 500 miles at operating costs roughly equivalent to those of the *Viscount;* the runway length required, allowing for full safety margins, is only 1,330 ft.

The 941 will sell for around NF 3.5 million ($700,000) provided the production run is for not less than 100 aircraft. First flight is expected in March 1961, and the aircraft should enter service in 1964. Breguet will almost certainly put the pressurized cabin 942 version into production to follow the 941.

●

The French national defence programme is expected to include an order for the production of 50 Mach 2 Dassault *Mirage IV* bombers for delivery between 1963 and 1965, as well as an order for an IRBM designated SSBS (*sol-sol balistique stratégique*) to succeed this aircraft. The SEREB group (Société d'Etude et de Réalisation d'Engins Balistiques) will probably get the SSBS contract. In the field of tactical weapons, several hundred *Mirage IIIs* are expected to be ordered, together with air-to-surface weapons.

Other provisions are expected to include participation in the second generation of NATO (short or vertical take-off) strike aircraft. Some mention will probably be made of the Dassault *Etendard IVM* which will be produced for the Navy, and the NATO naval patrol aircraft, Breguet 1150 ; Rolls-Royce *Tyne* units for the latter will probably be manufactured by Hispano-Suiza, which may also produce *Tynes* for the Franco-German *Transall* project.

The *Transall* itself will undoubtedly figure in the transport section of the bill, together with the Breguet 941 and 942 and almost certainly the Max Holste *Super Broussard.* In the civil field, the main effort will probably go into the *Caravelle* and its derivatives. Other items are expected to include the SS.10 and SS.11 anti-tank missiles and the *Hawk* ground-to-air weapon, training and light aircraft, and the *Alouette II* and *III* helicopters.

For the Navy the bill will most likely make provision for a third aircraft carrier, several missile-launching cruisers and a prototype missile escort vessel.

●

Bell Aircraft Corporation and Nord-Aviation have signed an agreement giving Bell an option on United States' manufacturing rights for the Nord supersonic CT.41 and subsonic CT.20 radio-controlled target missiles. Bell will also get engineering assistance from Nord on the French company's techniques in ramjets and high-performance flight items; Nord will assist Bell in adapting the drones to any U.S. requirements.

Nord-Aviation has already delivered approximately 350 jet-powered CT.20 drones to France, Britain, Italy and Sweden, and is now working on orders for an additional 100. The ramjet-powered CT.41 is undergoing flight tests in the Sahara.

Last November it was reported that Nord-Aviation and the Hawker Siddeley Group had also signed an agreement giving the British company rights for the manufacture and servicing of the CT.41.

●

MAN/Rolls-Royce collaboration : The British and Federal German Governments have now officially confirmed the agreement between Rolls-Royce Ltd. and the Maschinenfabrik Augsburg-Nürnberg AG engine subsidiary MAN Turbomotoren GmbH for joint development of the Rolls-Royce RB.153 lightweight jet engine. The main objective of the MAN/Rolls-Royce development work is reportedly the increase of the RB.153's thrust level from its original 3,300 lb class to some 4,400 lb. The engine is destined to power the projected West German VTOL single-seat combat aircraft under development by the Entwicklungsring Süd (Southern Development Group) as a possible successor to the Fiat G.91. First mention of the MAN/Rolls-Royce agreement was made in July, 1958, when it was announced that the two companies had signed an agreement covering licence production in Germany of Rolls-Royce jet engines and closer collaboration between the two companies in the field of powerplant development.

●

The Saab Aircraft Company of Linköping, Sweden, has secured distribution rights for the Swiss Pilatus *Porter* light transport in Sweden, Norway, Denmark and Finland, and has also acquired licence production rights. This agreement between Saab and the Pilatus Aircraft Works is probably the first step in a closer cooperation between the aircraft industries of two neutral countries. The *Porter* will be demonstrated in Sweden and Norway, and possibly also Finland, within the next few weeks.

●

The Sherman Fairchild Air Safety Writing Award is the name of an international prize offered by the U.S. Flight Safety Foundation to the journalist who writes the most objective and constructive article on flight safety. The first prize is $1,000 in cash and a plaque, the second prize $500, the third prize $250. Essays for the 1960 prize must reach the Flight Safety Foundation, 468, Park Avenue South, New York 16, N.Y., by midnight on April 15th. The prize was founded by Sherman Fairchild, pioneer of aircraft construction and father of modern aerial survey. The competition will be judged by Carl Ackerman, well-known foreign correspondent and for many years Dean of Columbia University School of Journalism; Lauren D. Lyman, Pulitzer Prize winner, former Aviation Editor of the New York Times and former Vice-President of United Aircraft Corporation; and Ansel E. Talbert, aviation journalist and Vice-President of the Flight Safety Foundation.

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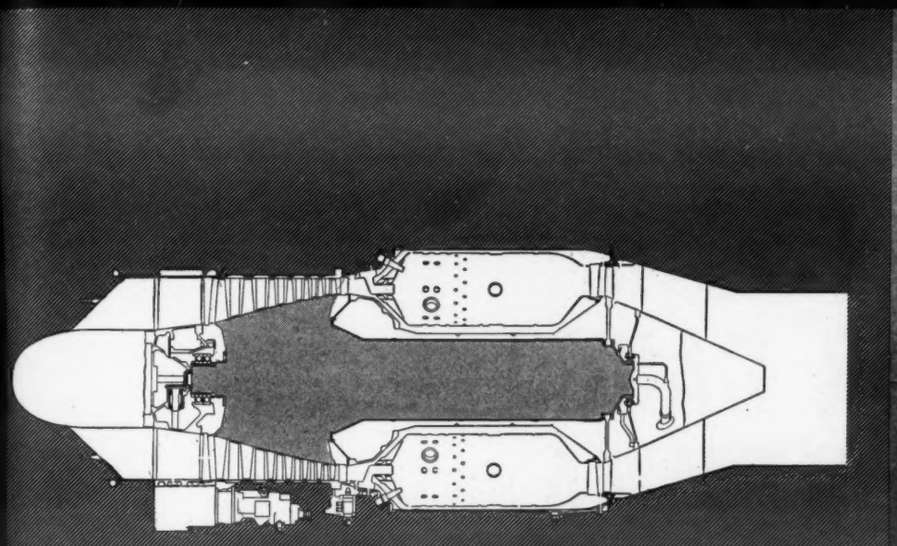
Orpheus turbojet—already flying in 6 different aircraft—now reaches 6,810-lb thrust dry, over 6:1 thrust/weight ratio...



ORPHEUS 803 - general arrangement showing the two-bearing layout

...ANOTHER ENGINEERING ADVANCE BY BRISTOL SIDDELEY

The design philosophy behind the Orpheus family of engines was based on two conflicting requirements—extremely light weight and exceptional reliability. That these requirements were successfully reconciled is shown by the fact that the Orpheus has been specified in five countries for no fewer than 14 distinct types of aircraft, six of which are already flying. The Orpheus is undoubtedly the most advanced medium-thrust turbojet engine in the world and the latest version, the B Or 12, has more than twice the thrust of the original Orpheus which first flew in 1955.

The Bristol Siddeley Orpheus B Or 12, like the earlier versions, achieves its outstanding performance through basic simplicity of design. Producing 6,810-lb thrust dry (8,170-lb thrust with simplified reheat), for a weight of 1,100 lb, the B Or 12 has a very high thrust/weight ratio of over 6:1. This is combined with a good specific fuel consumption (0.933 lb/lb/hr at maximum continuous rpm, sea-level static conditions), very compact dimensions (81.4 in from intake flange to exhaust flange; 32.4 in diameter), and minimum servicing requirements.

Omnipresent Orpheus

The Orpheus family has a far wider range of applications than any other aero-engine in its class. The design has been proved by a remarkable record of trouble-free operation and various Orpheus versions power aircraft ranging from trainers and executive transports to research aircraft and lightweight strike fighters. The last category includes the Fiat G 91, NATO's standard strike fighter, powered by the Orpheus 803 (shown above).

The Orpheus is in production in India and Italy as well as Great Britain, and will shortly be built in Germany.

BRISTOL SIDDELEY ENGINES LIMITED

DRAMATIC ANSWER TO THE AIR CARGO DILEMMA

Many air carriers, striving to answer perplexing questions presented by a growing air cargo industry, are facing a basic decision: should they convert outmoded piston engine passenger equipment and put it on to air cargo routes? Should they order proposed cargo jets with 100,000 lb. payloads? Should they wait for further turbo-fan evaluations before making their air cargo plane commitments?

Canadair's Forty Four, offers a simple, practical answer to these vital questions. It is an optimum-size, all-new, all-cargo turbo-prop airplane that, in terms of productivity, is vastly superior to converted piston engine equipment, and one that offers, in comparison with the big jets, a payload capacity that is not unrealistically high for profitable operations during the 1960's. Furthermore, the Forty Four suffers little or no operating penalties due to runway limitations, and there will be no community noise problems.

The Canadair Forty Four has a productivity two to three times that of converted piston aircraft, at the same cost per airplane mile, and has a profit potential that will quickly recover any losses on disposal of piston engine aircraft now being used or contemplated for cargo usage. On the other hand, the Forty Four with a payload capacity of 65,000 lbs. and low break-even point is ideally matched to the natural expansion of the cargo market and will begin immediately to operate at profitable load factors.

The Canadair Forty Four is flying now and is in production for the three largest all-cargo carriers in the United States, and can be introduced into existing fleets early in 1961. The Canadair Forty Four can operate in and out of all airports presently used by four-engined piston-powered aircraft. For example, the Forty Four needs only 6,400 ft. of runway for take-off with 90% of its maximum payload for a non-stop flight from say, Stockholm to Lisbon. Sophisticated design features, including swing tail and integral cargo handling equipment, slash direct and indirect costs.

Step-by-step savings and economies inherent in the Canadair Forty Four, combined with its very attractive price, let precious capital dollars work for better return quicker than other "proposed" equipment.

Thus General Dynamics Corporation's Canadian subsidiary, Canadair, the specialist in air cargo, proposes the Forty Four as the answer to air cargo's biggest dilemma.

Principal Features of the Canadair Forty Four

1. Low prime cost — less than $^2/_3$ the price of proposed jets.
2. Low operating costs — estimated at $1.30 per aircraft mile, and less than 4c per ton mile.
3. Right size for the 1960's — its present payload capacity is ideally matched to forecasted requirements.
4. No community noise problems — confirmed during present flight testing.
5. No airport or runway limitations — every major airport open to the Canadair Forty Four.
6. Growth potential — able to grow with the market.
7. Available for delivery in early 1961.

CANADAIR LIMITED, MONTREAL, CANADIAN SUBSIDIARY OF
GENERAL DYNAMICS CORPORATION

Enquiries may be directed to:
J. H. Davis, European Representative, Canadair Ltd., Princes House, 190 Piccadilly, London W. 1, England

44
CANADAIR FORTY FOUR

HEINKEL

TRADITION AUF NEUEN WEGEN

ERNST HEINKEL

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GERMAN AIR SHOW 1960

HANOVER AIRPORT

APRIL 24th - MAY 3rd

For the third year in succession the Bundesverband der Deutschen Luftfahrt-Industrie e.V. will be holding the

1960 GERMAN AIR SHOW

at Hanover Airport, from April 24th to May 3rd, to coincide with the German Industrial Fair.

In the spacious exhibition area, which has been considerably extended, aircraft, equipment and accessories manufactured by major German and foreign firms will be on view. Engines, electronic and optical equipment, precision engineering products, components, materials, aircraft safety equipment and many more items will be displayed in the exhibition hall. Airliners, business and sports aircraft, and trainers will be demonstrated in flight each day, and will be exhibited in the outdoor show, together with airport vehicles and equipment.

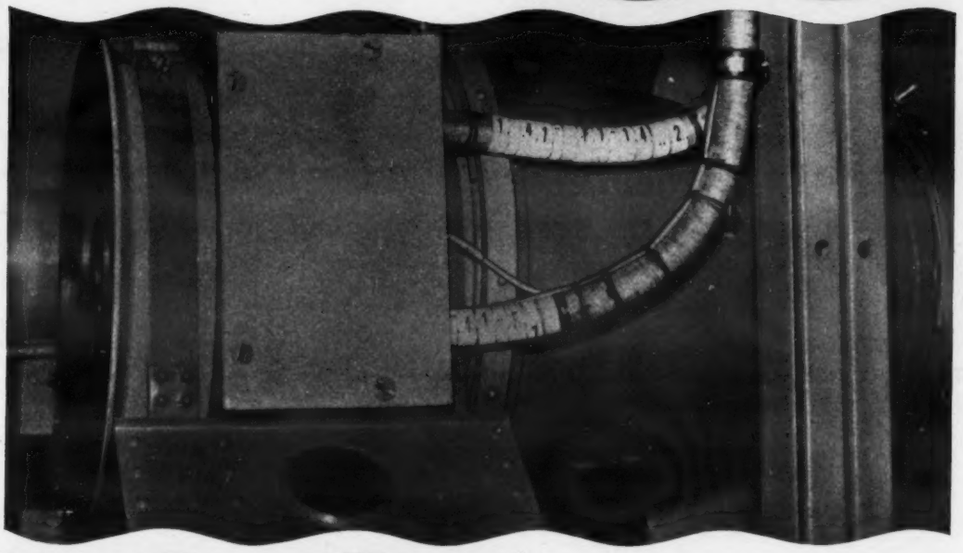
Organized by:

Bundesverband der Deutschen Luftfahrt-Industrie e.V., Bad Godesberg

Information and prospectus from Deutsche Messe- und Ausstellungs-AG., Hanover

Plannair blowers in the Vanguard

LOUVRE BOOST. Single stage axial flow blower unit 6PL161–248 operates on 27/28 volts d.c. running at a speed of 6,000 r.p.m. approximately with an output of 550 c.f.m. at 3″ s.w.g. measured at Sea Level. The unit is complete with radio suppression gear and functions as a louvre boost blower for air supply to the cabin.



TRANSFORMER RECTIFIER COOLING. Illustration shows four single-stage blower units type 3PL241-110 installed for transformer/rectifier cooling on the main d.c. power supply unit. Each blower operates on 200 volts, 3 phase, 400 cycles at a speed of 11,200 r.p.m. and gives an output of 150 c.f.m. at 4″ s.w.g. at design point at Sea Level. Four 4PL121-359 blowers are used for general cooling of the radio crate and each of these is fitted with dual centrifugal switches for operating a warning light and switching on stand-by blower in the event of motor failure.

CABIN RE-CIRCULATION. This unit (9PL241–274) has been designed and produced for re-circulation of cabin air. For its size it is particularly powerful, having an output of 1,280 c.f.m. at 15¼″ s.w.g. when running at a speed of 7,900 r.p.m. When operating on 27 volts d.c. the current input to the motor amounts to 160 amps. The motor, which has been specially developed for this blower, embodies unique cooling features for providing self-cooling and these include an internal re-circulating fan with air drawn through a hollow shaft. Thus the motor despite its high output is completely enclosed.

PLANNAIR

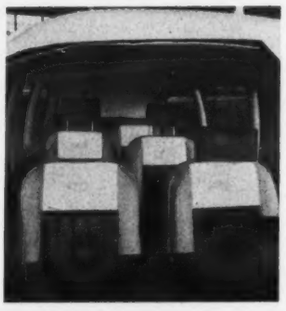
Plannair blowers are also supplied to customers' own requirements.

PLANNAIR LIMITED · WINDFIELD HOUSE · LEATHERHEAD · SURREY · ENGLAND · Tel: Leatherhead 4091/3 & 2231 PLA23b

PIPER AZTEC

New 215 mph (346 kph) Twin-Engine Transport

FAST... Aztec's jet-type "flying tail" adds speed, stability.



ROOMY... Five ride in roomy luxury, with ample allowance for baggage.

The Piper Aztec, newest, largest, fastest aircraft to join the Piper fleet, is an over-200-mph (320-kph) twin powered by two 250 hp Lycoming engines. The Aztec carries a useful load of *over one ton* (over 900 kgs) ... takes off in less space, lands in less space and has a higher single-engine ceiling than any other twin-engine airplane in its class carrying a similar payload. With full 144-gallon (544-litre) standard fuel, five 170-pound (77-kg.) passengers, full radio and instrumentation for instrument flight, the Aztec cruises 205 mph (330 kph) at 7,000 feet (2,100 metres) (75% power) and has range of over five hours. Piper production efficiency permits the Aztec, fully equipped, to be priced well below any other twin in its class.

EFFICIENT... Piper Aztec has highest single-engine ceiling of any plane in its class carrying similar payload.

AZTEC SPECIFICATIONS

Engines (2)	Lycoming O-540	
Horsepower and RPM	250 at 2575	
Gross Weight	(lbs) 4800	(kgs) 2177
Empty Weight	(lbs) 2775	(kgs) 1259
Useful Load	(lbs) 2025	(kgs) 918
Top Speed	(mph) 215	(kph) 346
Cruising Speed	(at 7000 ft)-205 mph	(at 2134 met)-330 kph
Stalling Speed	(mph) 62	(kph) 100
Rate of Climb	(fpm) 1650	(mpm) 503
Service Ceiling (ft)	22,500	(met) 6,858
Absolute Ceiling (ft)	23,750	(met) 7,239
Fuel Consumption	(gph) 28	(lph) 106
Max. Range with Standard Fuel	(miles) 1,400	(km) 2,253

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A PIPER PLANE FOR EVERY PURPOSE

APACHE. Four or five passenger twin, cruises 171 mph (275 kph). Most economical to buy and fly.

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TRI-PACER. CARIBBEAN lowest cost, easiest-to-fly, four-place aircraft.

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PAWNEE. New agricultural plane for efficient dispersal of dust or spray.

Twin after-burning engines give the USAF T-38 Talon high performance with safety

TO TRAIN SPACE AGE AIRMEN IN SUPERSONIC DEFENSE—NORTHROP'S T-38 TALON

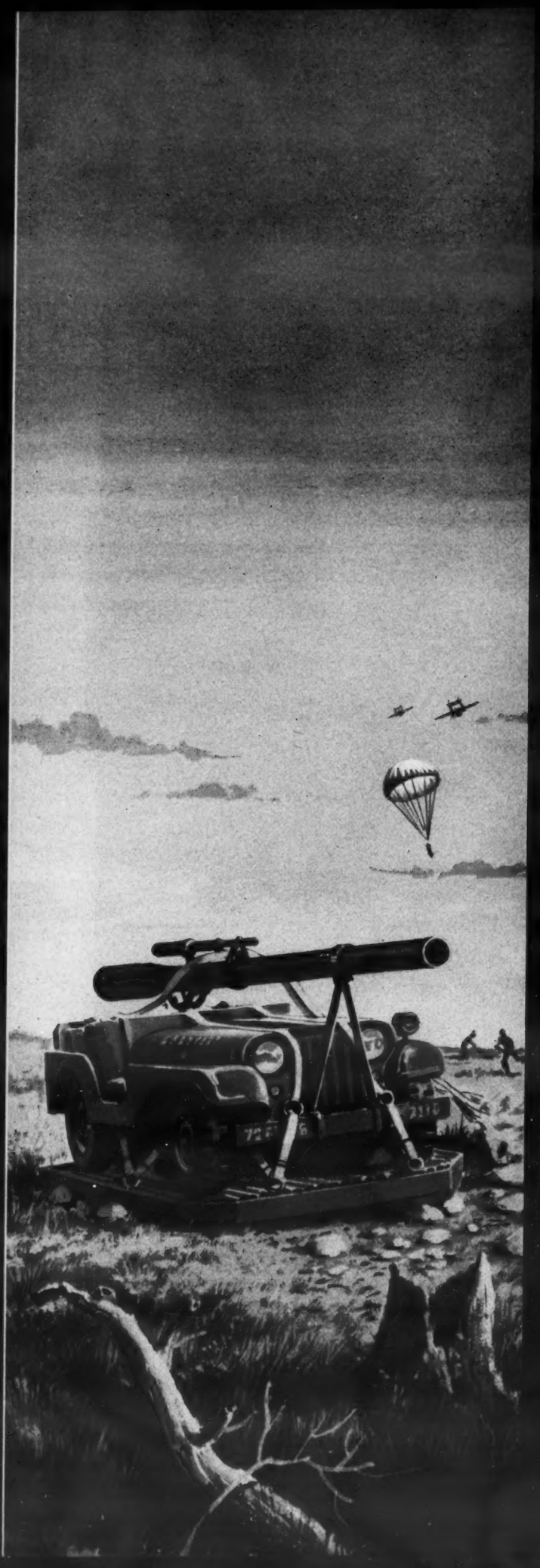
Northrop is now producing the T-38 Talon for the U.S. Air Force Air Training Command. Pilots who have flown the T-38 agree that this is the plane in which the new generation of airmen can safely master the art of supersonic flight.

The twin jet T-38 is a member of the same low-cost and simplified-design family as Northrop's N-156F Freedom Fighter. Both incorporate similar performance characteristics and are powered by General Electric's J85 engines. Both reflect lower production costs, require only half the fuel to operate, and are far easier to maintain than aircraft of comparable performance. Both the T-38 trainer and the N-156F fighter are flying and ready for the Free World today.

NORTHROP INTERNATIONAL

A Division of **NORTHROP CORPORATION**, Beverly Hills, California

Northrop's Mach 2 Freedom Fighter—the N-156F—the modern, multi-purpose fighter.



NEW BATTLEFIELD MOBILITY FOR CREW-SERVED WEAPONS

WITH THE VERTOL 107

The twin-turbine Vertol 107, prototype of the army YHC-1A light tactical helicopter, is giving new meaning to an old word — mobility.

In "shoot and scoot" tactics for crew served weapons, the YHC-1A can swiftly transport three 106mm battalion anti-tank rifles each with 4-man crew and ammunition. Terrain is no obstacle. Each crew and weapon can be dropped off at pin-pointed firing positions to ambush advancing armor with convergent fire. Within minutes they can be scooped up and redeployed to engage another target miles away.

With its rear loading ramp and unobstructed payload compartment, this helicopter has the ability to airlift a complete Little John system and crew, laying fire on a target 60 miles away 35 minutes after receipt of orders.

Vertol's advanced YHC-1A and the forthcoming YHC-1B (Chinook), provide battlefield transportation which equals the advanced firepower of MoMAR — Mobile Modern Army.

VERTOL Aircraft Corporation

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CANADIAN VERTOL AIRCRAFT LTD., ARNPRIOR, ONT.

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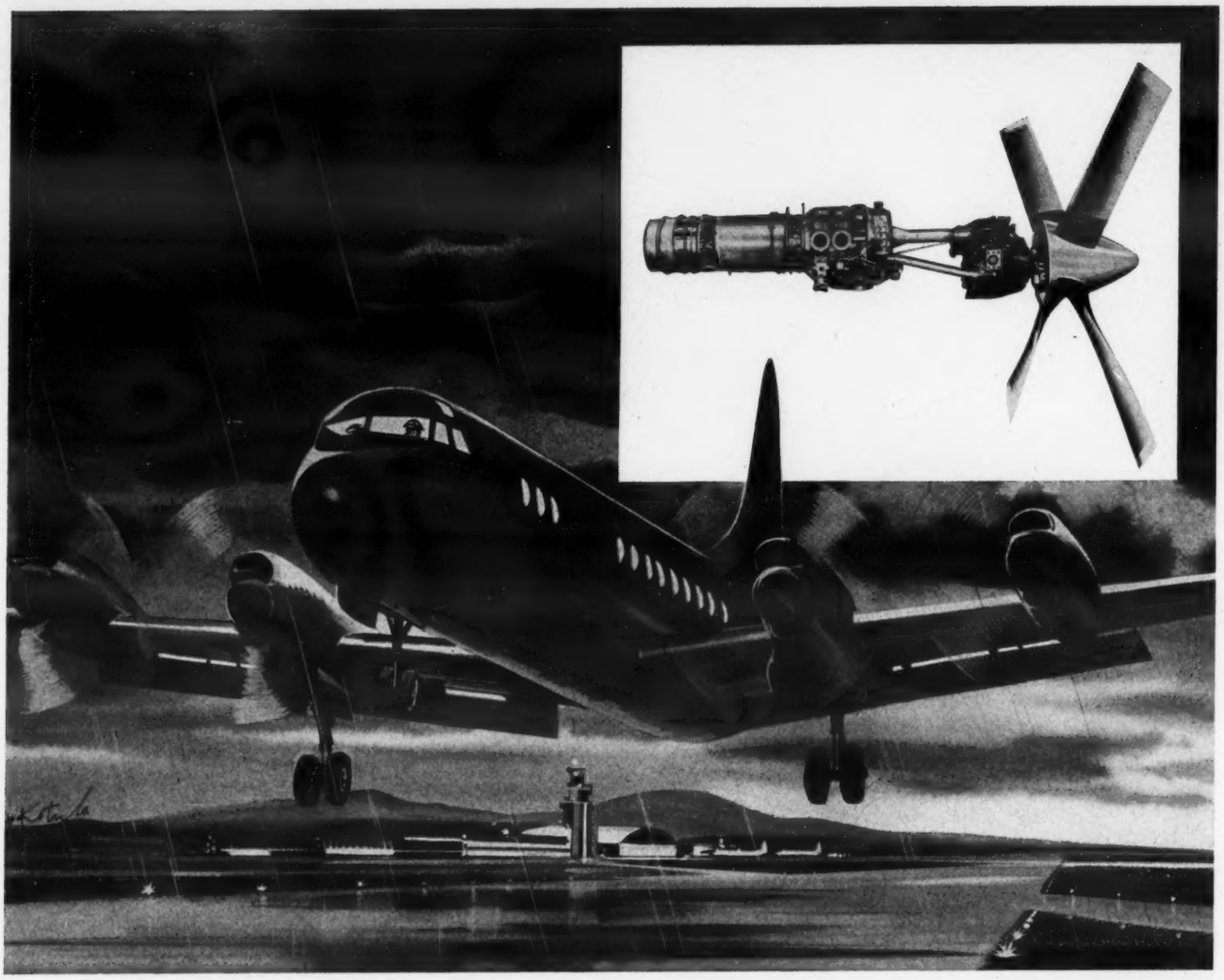

Instant power on demand

from Allison constant-speed Prop-Jet engines!

The constant in-flight engine speed of the Allison Model 501-D13 Prop-jet provides power for any necessity — instantly ! Flexibility of operation is assured in all speed ranges — from airport traffic patterns' velocities, up to and beyond 450 m.p.h.

The 501's inherent characteristics for split-second corrections, provide outstanding take-off, climb, cruise and landing performance. Braking action of the propellers is at hand for positive stops — even under extreme runway conditions. The 501 performs at altitudes up to 30,000 feet without penalty. Its 2.1 power-to-weight ratio is the best of today's prop-jets.

Modern Allison-powered Lockheed Electras and C-130 military transports are accumulating more than 125,000 hours of flight experience a month. Airlines utilization has averaged as much as 10.5 hours a day. Public acceptance is demonstrated by continuing high load factors. The Allison 501-D13 Prop-jet Engine with its matched Aeroproducts Turbo-propellers is also the logical choice for conversion of piston-powered aircraft.

Allison-powered Lockheed C-130

Allison-powered Lockheed Electra

Allison-powered Convair 340

ALLISON PROP-JET POWER

... utilizing the worldwide resources of General Motors

GM JET POWER

ADAPTABILITY IS ESSENTIAL TO SURVIVAL

AGAINST AIR ATTACK AS IN NATURE

Only animals who were adaptable enough have progressed along the path of evolution and flourish today. Those like the pareiasaurus which could not adapt themselves to varying conditions have gradually become extinct. So, too, when it comes to defence against air attack, a system that is not flexible is a hostage to fortune—for to believe that the attack will conform to an expected pattern would be foolhardy in the extreme.

DEFENCE MUST BE FLEXIBLE

Air defence, in which guided weapons will play an increasingly important part, must be flexible and prepared for danger from any direction. So when English Electric designed and constructed the Thunderbird ground-to-air guided missile, they built flexibility into it from the start. It was made capable of operating permanently from one site like any other fixed installation for as long as it was needed there. But, should the need arise, it could quickly be moved to meet whatever threat might develop.

Now in service with the Army and using standard service vehicles, it can be redeployed and in action within a matter of hours. Its inherent mobility allows quick changes of strategy, easy resiting of defence and provides the flexibility which is of ever increasing importance to present and future air defence.

New Developments

Evolution is going on. Already the successor to Thunderbird has been under development for some considerable time. Employing advanced techniques and retaining its full mobility it will have, among other things, increased low level capability and increased range.

'ENGLISH ELECTRIC' THUNDERBIRD

ENGLISH ELECTRIC AVIATION LIMITED · *GUIDED WEAPONS DIVISION* · LUTON · STEVENAGE · WOOMERA

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GW.25

Here's why the world's major airlines are powered by Champion spark plugs

Champion is the spark plug and jet igniter specialist—with incomparable experience and research-production facilities.

Through the years, Champion has been the leader in development of better spark plugs, better jet igniters.

Airlines, business fleets and private aircraft throughout the world fly on Champions because these spark plugs have *proved their dependability* through the years.

Champion has grown *with* the aircraft industry. As engines became more demanding, Champion met those demands. Today, Champion specialists are busy in a new million-dollar Research Building adjacent the main manufacturing plant at Toledo, Ohio, USA—busy developing spark plugs and jet igniters to give *your* aircraft engine its finest performance.

For peak engine performance regardless of operating extremes—desert to Arctic—fly with dependable Champions.

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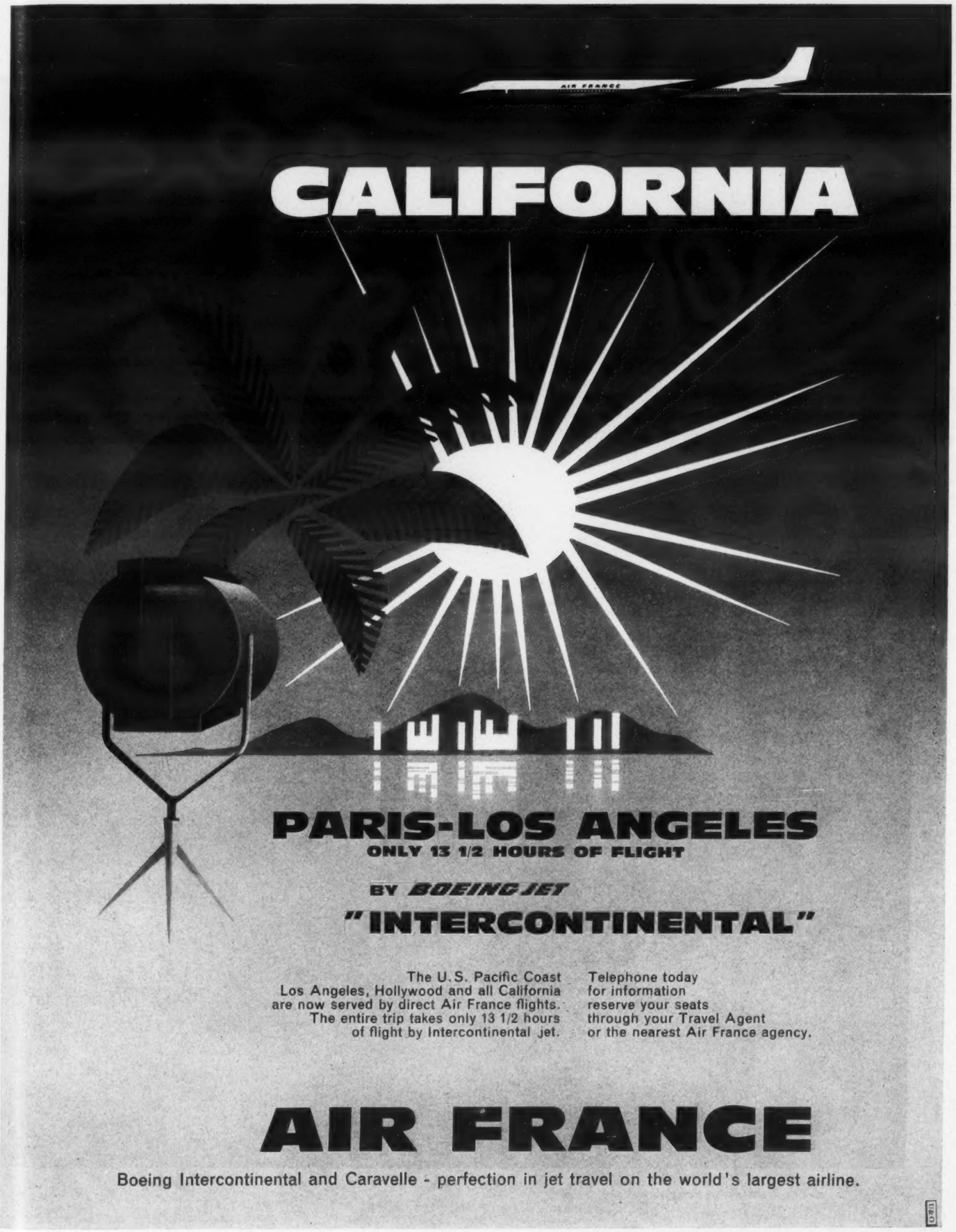
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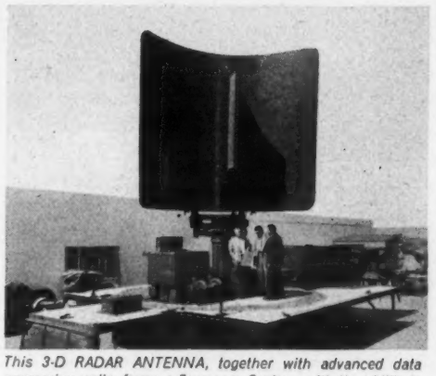
TARAN (Tactical Attack Radar and Navigator) —the optimum solution to the all-weather tactical mission problem—is typical of the important new electronic systems being developed by the Hughes Aircraft Company.

The TARAN system is designed to enable pilots to fly blind at very low altitudes in any kind of weather—and actually deliver any kind of armament to tactical targets.

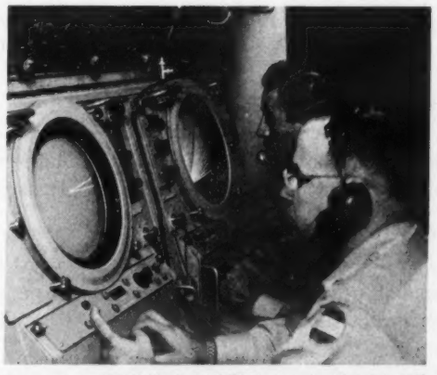
TARAN's amazing abilities are based on several major electronic advancements: a Radar System with several times the range and azimuth resolution of current radars; an Automatic Navigation and Display System which pinpoints position continuously and automatically corrects for any navigational deviations; a unique Terrain Clearance Indicator which warns the pilot of any obstacles when flying at low altitudes; a Radar Antenna utilizing electronic rather than mechanical lobing.

Equally important, the TARAN system is backed by extensive experience gained in developing and manufacturing over 16,000 reliable, high-performance all-weather interceptor systems.

TARAN is but one of a long list of important electronics systems and devices developed and manufactured by Hughes Aircraft Company. These activities cover virtually every electronic field: air-to-air guided missiles, advanced airborne control systems, space ferries, ground-control-radar surveillance systems, microwave communications systems and others. Commercial products include: diodes, transistors, rectifiers, traveling wave tubes and direct-view storage tubes. The reliability and operational capabilities of these systems and components have earned them the confidence of thousands of users throughout the free world.



This 3-D RADAR ANTENNA, together with advanced data processing units, forms a Frescanar System, with the ability to coordinate the fire power of a complex of guided missile batteries. Able to serve large defense zone areas, this Hughes Aircraft Company system greatly extends the capabilities of present-day defense armament.



Dual console FRESCANAR READOUT gives target range and bearing on left, altitude on right. Digitally programmed information from the 3-D antenna is presented on scores of targets at ranges in the hundreds of miles.

For further information please write to Hughes International, a Division of Hughes Aircraft Company, Culver City, California, U.S.A.

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A mobile unit for starting, air-conditioning, de-icing and testing the jet airliners of today

STARTING · AIR CONDITIONING · DE-ICING
The Air Partner is a surge-free rotary screw compressor of the Lysholm type designed for starting, air conditioning and de-icing all jet and turbo-prop airliners having air turbine starters.

A SUCCESSFUL COMBINATION
Atlas Copco, the world's largest organisation devoted exclusively to the manufacture of compressed air equipment, combined aeronautical expertise with compressor know-how to produce this multi-purpose unit.

STARTING
The Air Partner delivers a continuous flow of warm, oil-free air to turn the engine over constantly thus eliminating mis-starts.

AIR CONDITIONING
The Air Partner becomes an air conditioning unit by merely flicking the appropriate switches and pressing a button, a matter of seconds.

DE-ICING
A special mouthpiece attached to the air hose enables the wings and fuselage to be 'sprayed' with warm air. Removal of ice and sleet from windshields, wing leading edges, and air intake lips is achieved by using the ordinary de-icing outlets of the aircraft.

SIMPLE MAINTENANCE
The Air Partner has no wearing parts. It consists of two screw rotors which intermesh but never touch one another or the casing. 10,000 hours is the normal period between overhauls for screw compressors of this type.
Maintenance operations can be carried out by airline personnel anywhere in the world or through the Atlas Copco sales and service organisation established in 90 countries.

TWO MODELS
Air Partner M-3 consists of two identical units, each including a compressor connected to a standard petrol or diesel engine, for starting, air conditioning, de-icing and checking auxiliary systems.
Air Partner M-2 consists of one rotary screw compressor connected to a standard petrol or diesel engine for starting and limited air conditioning.

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Interview with Georges Héreil

Since the beginning of the year Sud-Aviation has recorded one triumph after another: On January 7th General Electric ordered a Caravelle *for conversion to GE jet engines; on February 10th the Douglas Aircraft Company and Sud-Aviation signed an agreement of far-reaching importance, under which the American company's sales organization throughout the world is placed at the service of the* Caravelle, *and Douglas obtains the rights to build the French aircraft under licence in the United States; finally, on February 26th, United Air Lines, one of the USA's "Big Five," placed a firm order for 20* Caravelles *with an option on a further 20.*

In order to give Interavia *readers an authoritative opinion on these developments, Georges Février,* Interavia's *Paris Manager, asked Sud-Aviation President Georges Héreil for an interview, the main points of which are given below.* Eds.

In spite of many claims on his time Georges Héreil is always easy to approach—provided one happens to be in the same city as he is! I was fortunate enough to find him in Paris between a trip to the United States and a flight to Portugal. He received me in his office in the Champs-Elysées; the atmosphere was hushed, the desk empty, not a file was to be seen. As usual, the President was calm and smiling, and showed neither exuberance nor excessive optimism.

"Of course I am satisfied. Who would not be in my position? But it is all happening as I had foreseen: in aviation, as elsewhere in life, all things come to him who waits.

"The three aspects of the American picture are of enormous interest from many points of view.

"Firstly, the contract with General Electric is a sign that engine manufacturers are beginning to cooperate more closely with airframe constructors. The *Caravelle* is an aircraft of great potential interest, capable of many different developments in which the CJ-805 can play its part; in buying an airframe and adapting, fitting and testing engines to power it, General Electric is undeniably placing a vote of confidence in future *Caravelles*.

"The second aspect of the picture—cooperation with a large American concern—caused me some heart-searching. How was I to choose between Boeing, General Dynamics and Douglas? I finally selected Douglas, but I am proud to say that I have not lost the friendship of either of the other companies.

"In associating with the great American company, whose name in many countries is synonymous with that of " aircraft," we are taking the long view. Both Douglas and ourselves are looking to the future and to the diversification which we shall ultimately have to undertake. As far as the present and the immediate future are concerned, the Douglas-Sud-Aviation association holds two major trumps in the *Caravelle* and the DC-8, which will later be joined by the medium- to long-range *Caravelle XIV* and the high-capacity *Super DC-8* long-haul aircraft. The two latter will be the result of close collaboration between our companies. We are constantly exchanging technicians, and the number of exchanges will increase . . .

"Last but not least comes the United Air Lines order for 20 *Caravelles*. This is the first time in the history of aviation that one of America's "Big Five" has bought aircraft from outside the United States.

"The 20 aircraft already ordered—and the 20 others on which UAL has taken an option—will be built in the closest collaboration with the carrier. The *Caravelle VI R* is, in fact, largely the result of 220 modifications requested by United Air Lines. All the aircraft ordered will be delivered next year."

"What are your views on the future?"

"The prospects are even more encouraging than at present. I should be most surprised if other major American airlines—who are already in touch with Douglas—do not follow UAL's lead in a very short time. We are already investigating the possibility of increasing our monthly output.

"I am also firmly convinced that the *Caravelle XIV* will be a success. This medium- to long-range aircraft, which will have the same flying qualities and the same standard of comfort as the present-day Caravelles, need fear no competitors . . . With its non-stop range of 2,000 to 2,200 miles, the *Caravelle XIV* will fulfil a definite requirement. It will be faster than present *Caravelles* because it will cover longer stages and have more powerful engines while retaining the exceptional qualities of the current model.

"Do you know what a leading flight captain once said to me after testing all the commercial jets? 'The *Caravelle*? It's like riding a bicycle!' An unorthodox compliment, you may say, but perhaps the most flattering I have ever received . . ."

Republic Lands in Amsterdam

The growing participation of American manufacturers in the European aircraft industry was outlined in the February issue of *Interavia*. As the above interview shows, this development is continuing. And now *Republic Aviation Corporation*, of Farmingdale, N.J., has also decided to venture across the Big Pond and has concluded an agreement for close collaboration with the *Royal Netherlands Aircraft Factories Fokker*, of Amsterdam.

Under this agreement Republic not only acquires a qualified minority (roughly one third) in the Fokker capital, but will also make the full weight of the experience gained from its $2.5 million VTOL research programme available to the Dutch company. This will put Fokker in a position to offer NATO a VTOL aircraft specially designed to meet the latter's requirements. Republic's long-term objective in signing the agreement is to obtain a firm footing in the European market for aircraft and missiles, without having to set up its own production facilities in the Old Continent.

Cooperation between the two companies will not be restricted to individual development projects, but will also concern a large portion of each company's work programme For example, it is planned to transfer to Fokker the major part of the spares production and overhaul work for the F-84 fighter, of which Republic has supplied 4,000 to the various NATO countries during the past decade. Fokker will also play an important part in the overhaul, repair, modification and ground support equipment programme for the F-105D *Thunderchief*, which will shortly be deployed in large numbers with the USAF in Europe. Republic's order backlog for the *Thunderchief* now stands at roughly $500 million. It is also probable that the Republic-designed reconnaissance and observation drone vehicles will find employment with NATO forces, in which case Fokker should acquire yet another new field of activity.

It should be stressed that Fokker's ine dependence will not be affected by th agreement with Republic, so that its existine programme—quantity production of thg *Friendship*, licence manufacture of the F-104G *Starfighter* and the Breguet 1150 *Atlantic*, the *Hawk* anti-aircraft missile, maintenance and overhaul of NATO aircraft —will continue undisturbed.

INTERNATIONAL MEETINGS AND CONFERENCES

Apr. 14th-24th : International Air and Space Exposition. Los Angeles, Calif.

Apr. 19th : IATA Legal Committee, 25th Meeting. Virginia Beach, Va.

Apr. 19th-21st : International Symposium on Active Networks and Feedback Systems. New York.

Apr. 19th-21st : International Airline Navigators Council, 10th Annual Convention. New York.

Apr. 20th-22nd : National Symposium on Manned Space Stations, Institute of the Aeronautical Sciences, NASA and the Rand Corp. Los Angeles, Calif.

Apr. 21st-22nd : American Institute of Mining, Metallurgical and Petroleum Engineers, Southwest Metals and Minerals Conference : "Metals and Materials for the Space Age." Los Angeles, Calif.

Apr. 21st-23rd : IATA, Production Planning and Control Group. Madrid.

Apr. 24th-May 3rd : German Air Show 1960. Hanover-Langenhagen.

Apr. 25th : IATA Traffic Conference 2 Agency Committee, 34th Meeting. Paris.

Apr. 25th-29th : AGARD Wind Tunnel and Model Testing Panel, Boundary Layer Research. London, England.

Apr. 26th-28th : Airlines Electronic Maintenance. Hollywood, Calif.

Apr. 27th-28th : Cincinnati Chapter of the American Society for Metals, National Meeting on Space Age Materials. Cincinnati, Ohio.

May 1st-4th : Aviation Writers Association, Annual Meeting. Los Angeles, Calif.

May 5th : Royal Aeronautical Society, Annual General Meeting. London.

May 7th : IATA Traffic Advisory Committee, 23rd Meeting. Puerto Rico or Bahamas.

May 9th : IATA Cost Committee. Puerto Rico or Bahamas.

May 9th-13th : Society of Photographic Scientists and Engineers, Annual Conference. Subject : Aerial Reconnaissance. Los Angeles, Calif.

May 10th : IATA Spring Meeting of Composite and Joint Traffic Conferences. Puerto Rico or Bahamas.

May 10th-12th : ATA Purchasing Committee. New York.

May 11th : IATA Technical Committee, 31st Meeting. Lucerne.

May 11th-14th : American Helicopter Society, 16th Annual National Forum. Washington, D.C.

May 18th : IATA Financial Committee, 19th Meeting. Venice.

May 19th : 48th Wilbur Wright Memorial Lecture. By Professor M. J. Lighthill, F.R.S. London.

May 22nd-26th : Airport Operators Council, Annual Meeting. Columbus, Ohio.

May 23rd-24th : Arbeitsgemeinschaft Deutscher Verkehrsflughäfen (Association of German Airport Operators), Annual Meeting. Bremen.

May 23rd-25th : IAS, AIEE, ARS and ISA Telemetering Conference. Santa Monica, Calif.

May 23rd-28th : International Instruments, Electronics and Automation Exhibition. London.

May 24th : The Society of Instrument Technology, Annual General Meeting and Presidential Address. London.

May 24th-28th : Japanese Rocket Society, Second International Symposium on Rockets and Astronautics. Tokyo.

May 26th-June 5th : 12th International Trade Fair. Luxemburg.

Three Budgets: One Objective

A comparison of the current defence estimates of the USA, Great Britain and France is interesting from a number of viewpoints, despite considerable differences in the economic and technical power of the three countries.

The United States, for example, pays out $45,000 million a year for the security of the Free World. Great Britain's defence expenditure runs to about a tenth of this sum, i.e., about $4,500 million, and France's budget amounts to $3,400 million. In other words, the USA spends 11.2 percent of its gross national income on defence, Great Britain 8 percent and France 8.4 percent. In terms of manpower, the USA's fighting strength is 2,435,000, Great Britain's only 614,000, and France's over 1 million. The French military service period is 28 months, against 24 in Great Britain and the United States.

The technological resources are also very different, since in this respect Great Britain and France lag far behind the United States with its vast potential.

*

In the case of the United States, the accent is naturally on missiles, and it is highly unlikely that American activities in the ballistic field will be curtailed as a result of the current controversy regarding the relationship between the respective missile strengths of America and the USSR. On the contrary, the number of *Atlas* and *Titan* squadrons has been raised from 20 to 27.

The appropriations required for defence against surprise attack from the air have been considerably increased to enable Strategic Air Command to escape destruction. New aircraft production for SAC is limited to a few additional Convair B-58s. Interceptors are being superseded by *Bomarcs*.

Of the longer-term projects, the *Minuteman*, which will ensure mobility on land, is probably the most important ; mobility at sea will be provided by the submarine-launched *Polaris*.

Foreign military aid is also expected to be increased, but will be divided into two categories: scientific and technical assistance to the USA's more prosperous allies, and more concrete aid to poorer countries such as Korea, Formosa, Greece, Turkey etc.

The new United States budget requests appropriations for the procurement of some 1,500 new aircraft of all types, representing an expenditure of some $6,000 million. Missiles are expected to account for about $4,000 million in appropriations.

*

The entire British defence programme is contained in the White Paper recently published by the successor to Duncan Sandys. For reasons which are, perhaps, industrial rather than military, the Royal Air Force is keeping its long-range *Lightning* fighter squadrons. The British press is, however, becoming somewhat critical as regards the funds still devoted to a purely defensive system, as the threat now comes from ballistic missiles against which aircraft, and even surface-to-air missiles, will be completely ineffective. But more important than this issue is the *Blue Streak* controversy. In view of the fact that the accuracy of the enemy's missiles has considerably increased, is it still possible to base an effective deterrent on a combination of subsonic bombers (even if equipped with air-to-ground missiles) and liquid-propellant rockets which are static and hence relatively easy to destroy ?

The British are now seriously questioning the efficacity of the deterrent policy they have followed hitherto. However efficient the warning system which may be adopted, the Royal Air Force bombers are highly vulnerable on the ground. Even if they did escape destruction, it is doubtful whether, with their relatively low penetration speeds, they would be able to get close enough to their targets to fire their air-to-surface missiles.

As for the British ballistic missile, this, even if installed in an underground silo, would still be relatively vulnerable to attacks from other missiles if the geographical coordinates of the British launching sites were known. And it would be very difficult indeed to keep their positions secret. This is the preoccupation which can be read between the lines of the new White Paper.

*

As for France, her defence expenditure is of necessity affected by the war in Algeria, which swallows up some 10,000 million new francs (1 million new francs = U.S.$202,000) a year. In the field of research and manufacturing, however, the Government has managed to find some 5,500 million francs for research, capital investment and quantity production for the three armed forces. In the Air Force sector procurement has, admittedly, been limited to 100 new *Mirage IIIs*, 50 *Mirage IVs* and 130 Fouga *Magister* trainers, the total expenditure envisaged for the current year amounting to a bare 1,150 million francs. The funds allocated for research (470 million) and to the inter-service heading (nuclear projects 420 million; missiles 270 million) no doubt include appropriations for research and development work on the SEREB missile, which France intends to pursue either on her own or with assistance from her allies.

If asked to describe the French defence programme, one might say that it marks a phase of transition, though the burden of the war in Algeria is seriously impeding the evolution of the new army out of the old.

France is lagging far behind in the missile field and is apparently finding increasing difficulty in achieving her goal of technical and logistic independence and providing for herself the armament which she considers necessary to her security. In striving to win this independence she is condemning herself, like Great Britain, to spending large sums of money on formulae which are more or less out of date.

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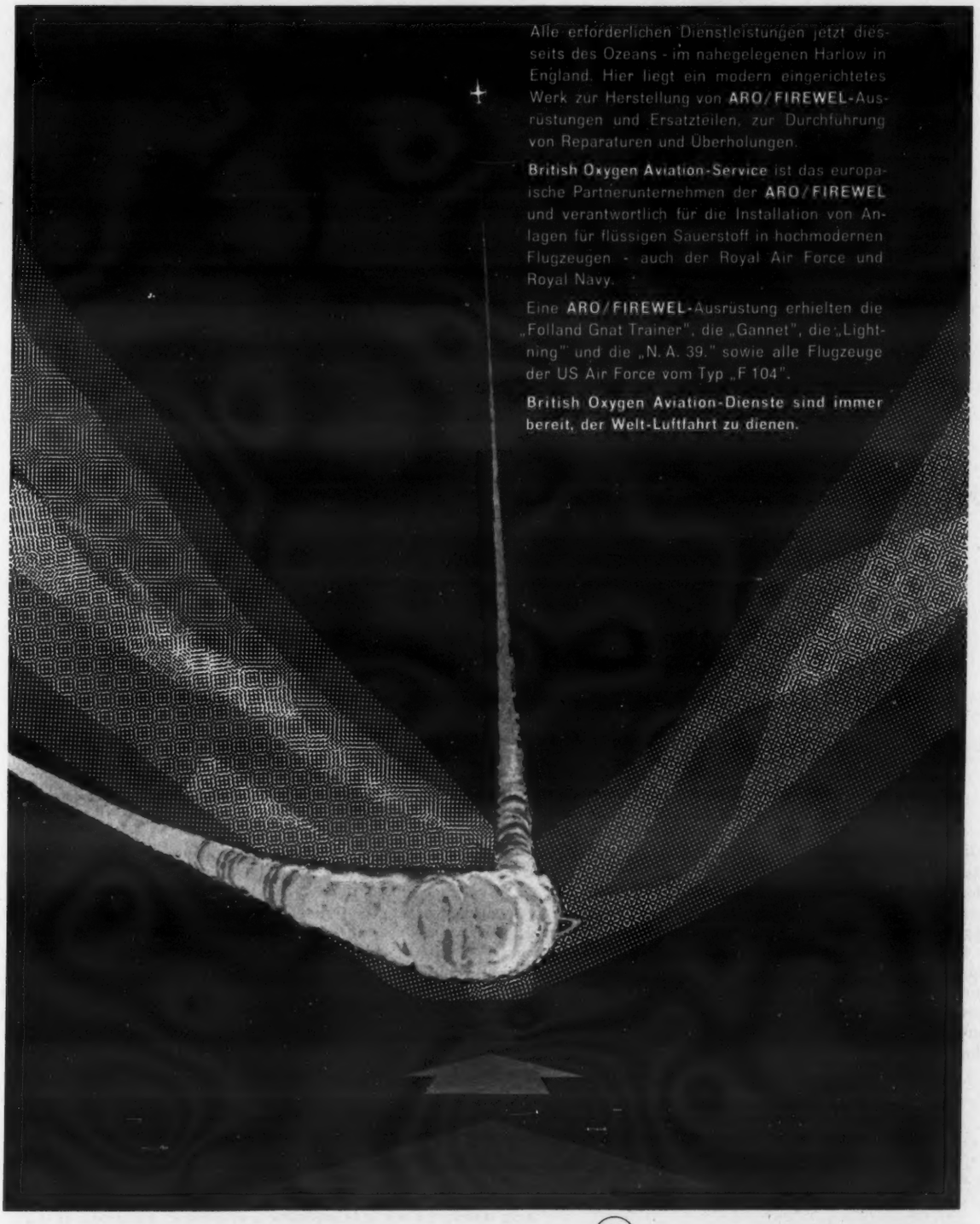

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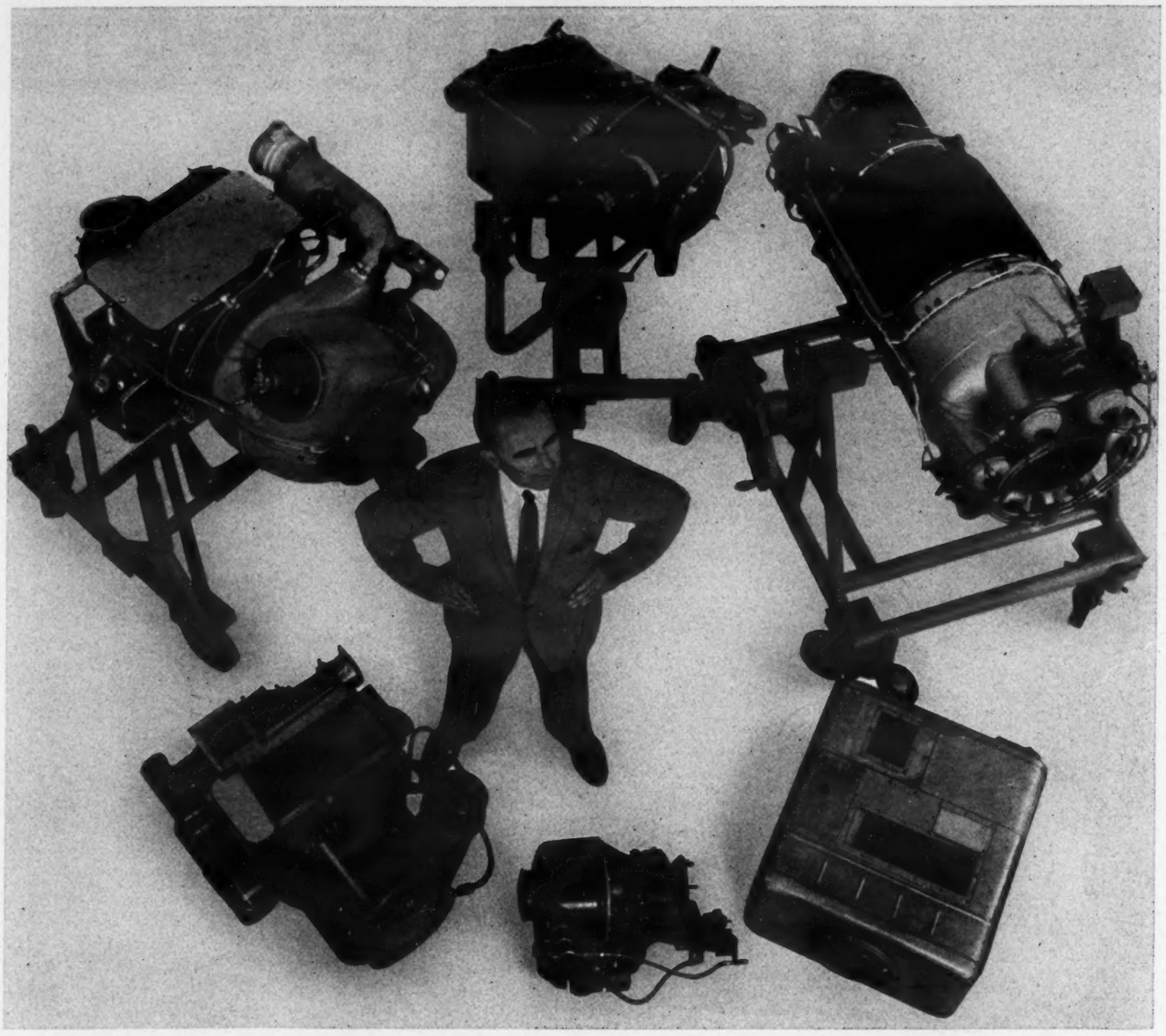

Helmut Schelp, chief engineer, AiResearch Manufacturing Division of Arizona, Phoenix, surrounded by typical gas turbines now in production ranging in size from 30 to 850 hp. Clockwise from the top : GTC 85-28 GTCP 105 • GTP 70-6 • GTP 30-1 • GTP 70-10 • GTU 85-2.

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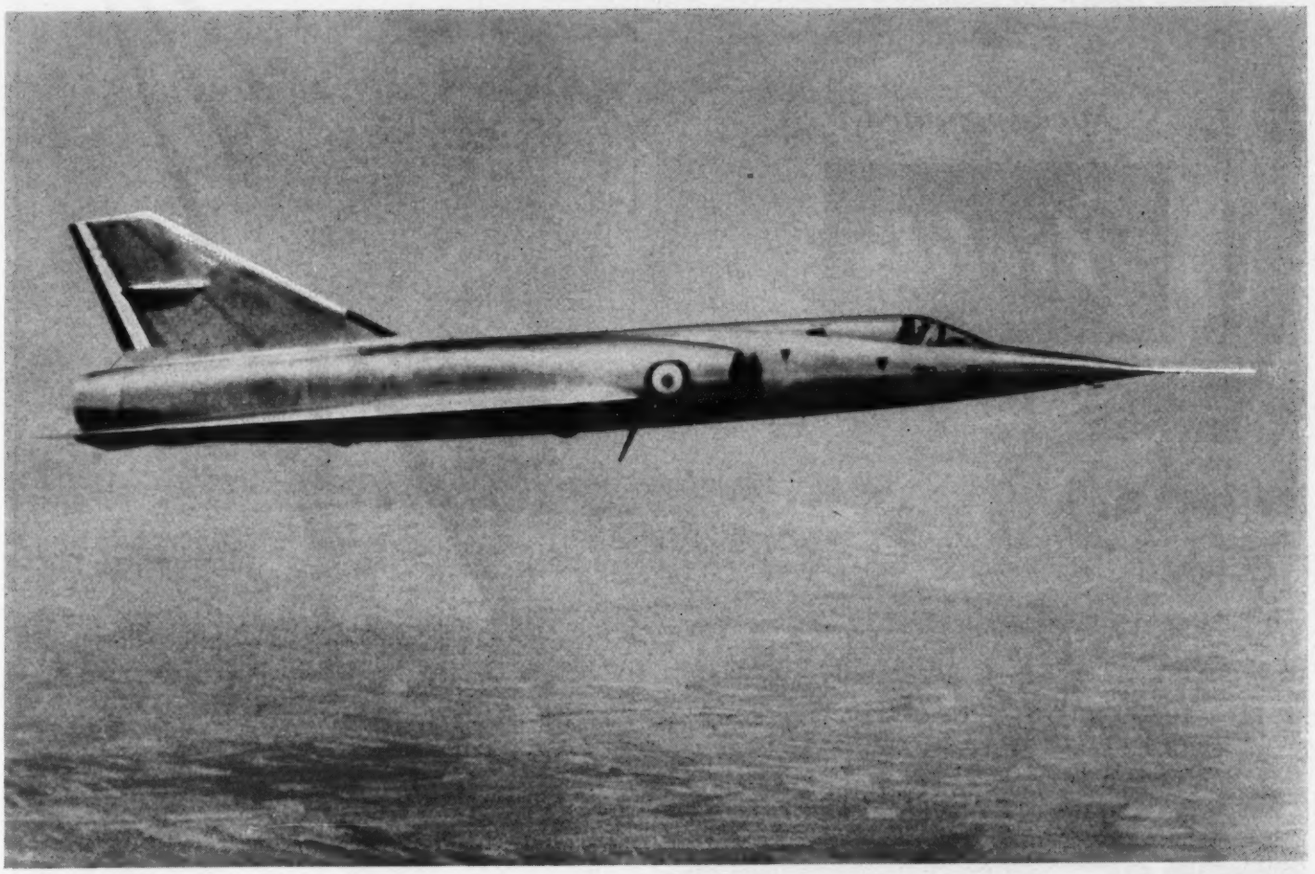

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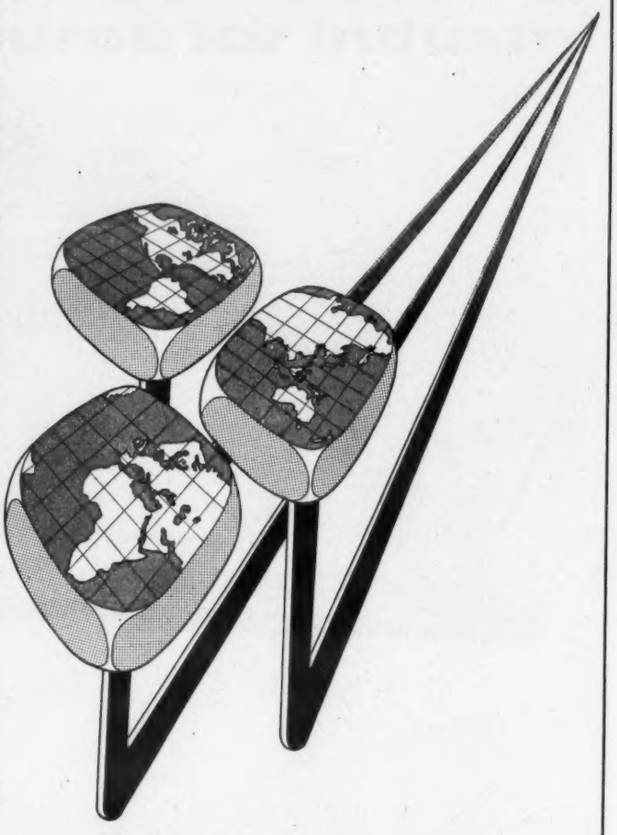

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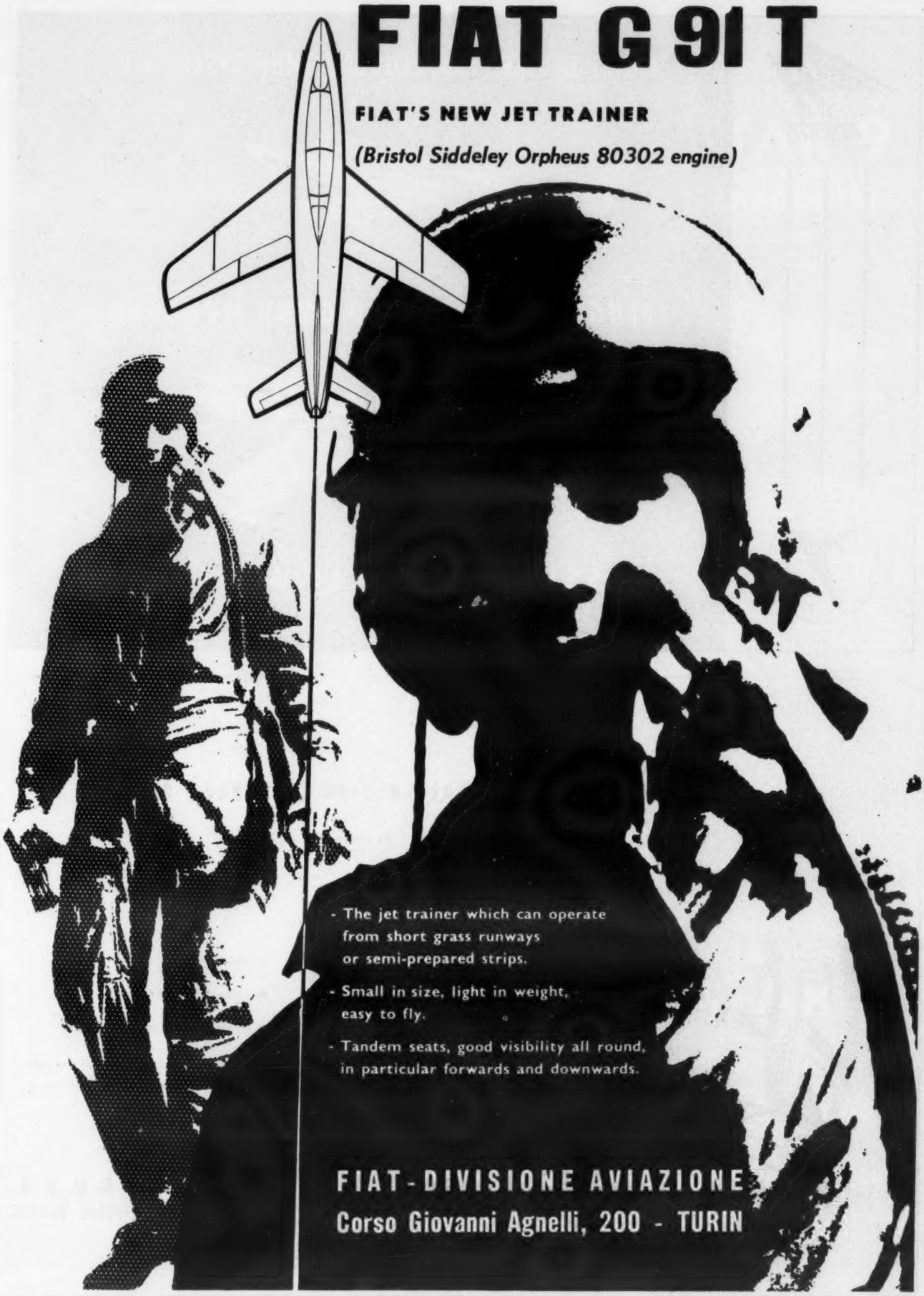

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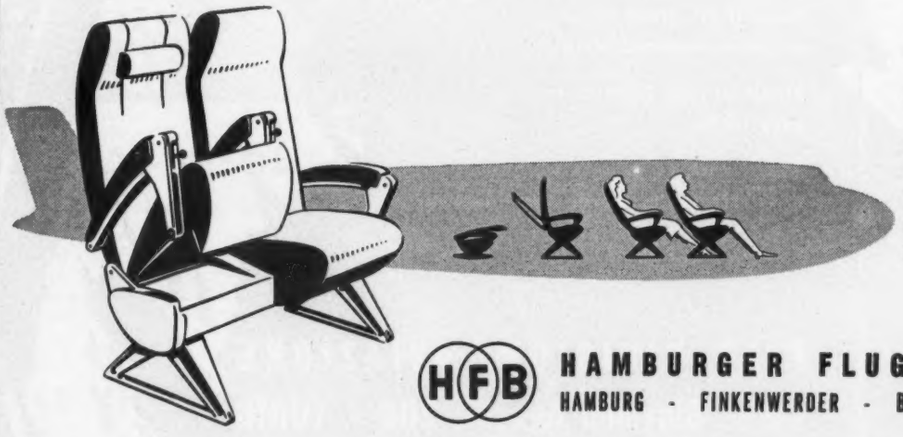

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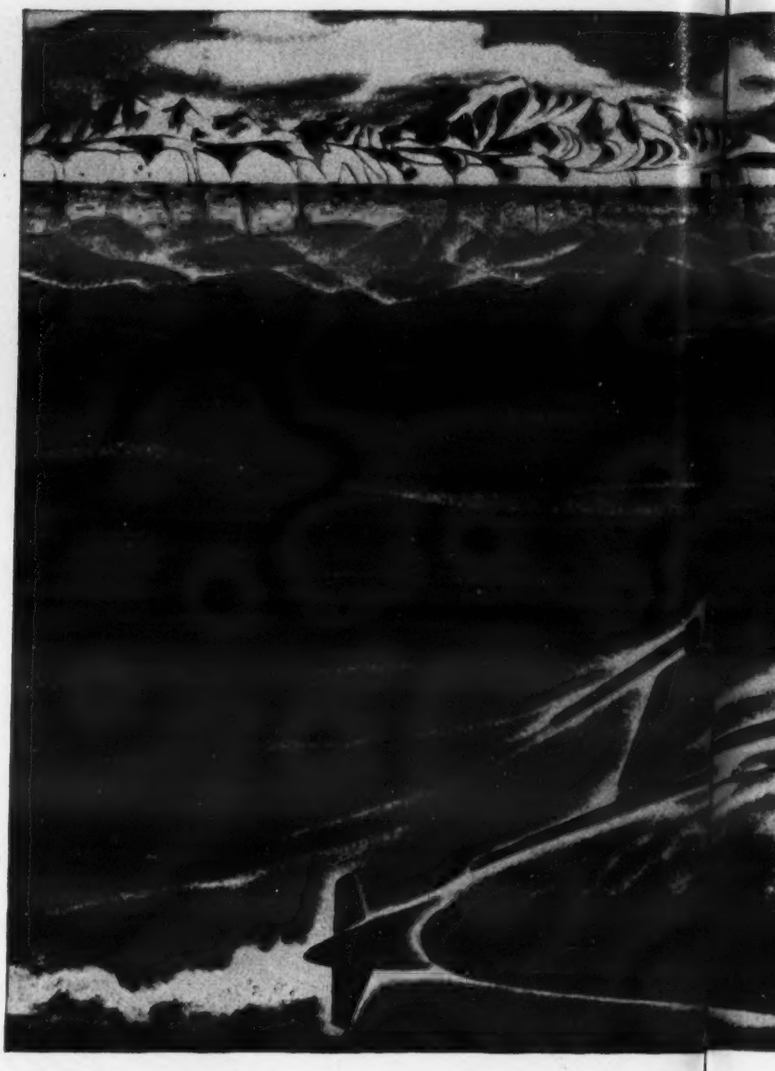

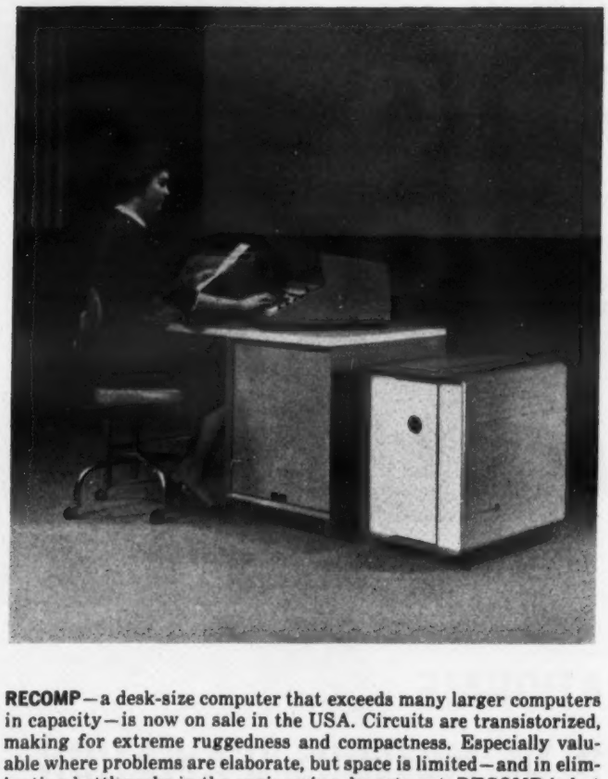

RECOMP—a desk-size computer that exceeds many larger computers in capacity—is now on sale in the USA. Circuits are transistorized, making for extreme ruggedness and compactness. Especially valuable where problems are elaborate, but space is limited—and in eliminating bottlenecks in the engineering department. RECOMP is but one of many imaginative electronic devices developed by the Autonetics Division of North American Aviation to meet modern needs.

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As the USS Nautilus sped swiftly through the dark, frigid waters beneath the North Pole, her captain knew his *exact* position each instant. This information came from an inertial autonavigator perfected by the Autonetics Division of North American Aviation.

Even more advanced inertial navigation systems from Autonetics are now in production for the U.S. Navy. This forecasts the day when such systems will be used by ocean liners and freighters, enabling them to proceed to their destinations on pre-programmed courses, monitored by watchkeeping officers as required. Autonetics is also producing or developing specialized versions of autonavigators for America's space vehicles.

As one of the world's foremost electronic equipment producers, Autonetics makes products whose usefulness ranges from the ocean depths to outer space.

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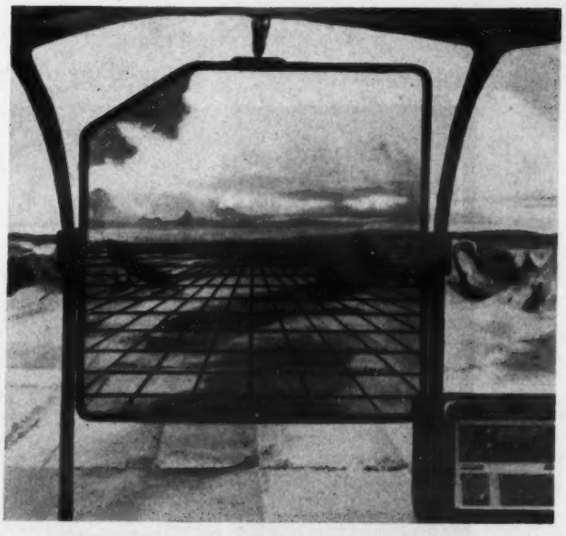
space. In addition to the inertial navigation systems that help pilot submarines or guided missiles, Autonetics produces automatic landing systems, a unique pilot's optical display, multi-purpose radar devices, automatic checkout equipment and portable, low-cost digital computers. With highly skilled personnel and modern facilities, Autonetics is one of the few organizations in the world that designs and quantity-produces complete and reliable automatic control systems. Its pace-setting position is underscored by many history-making accomplishments.

Generations of research and development in electro-mechanics have been telescoped into little more than a decade at Autonetics, which now employs over 15,000 scientists, engineers, technicians and supporting personnel. The Autonetics branch office at Geneva, Switzerland, is at your service.



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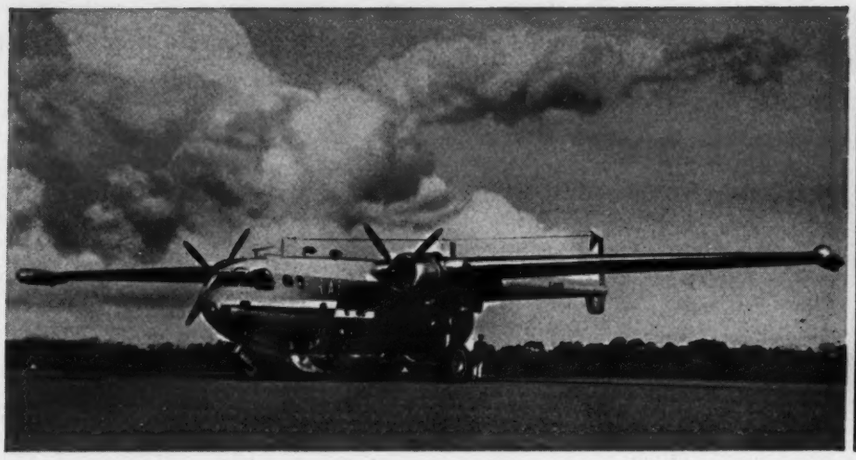

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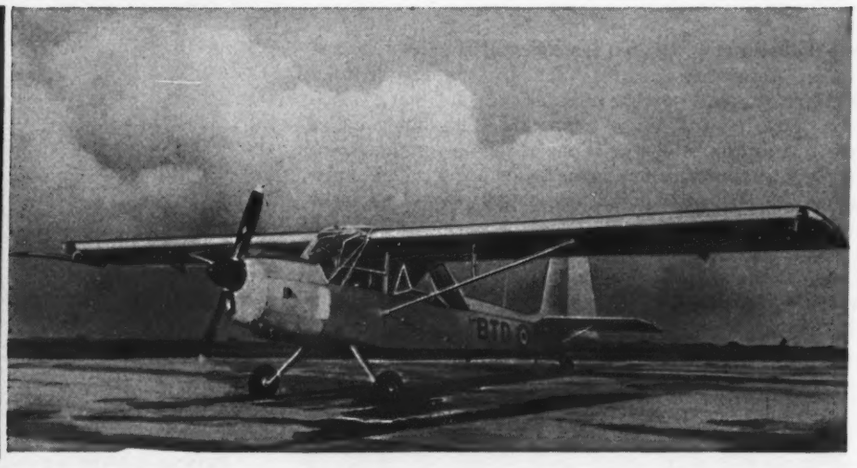

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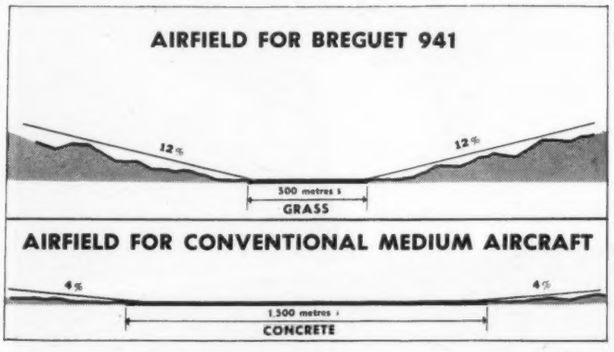
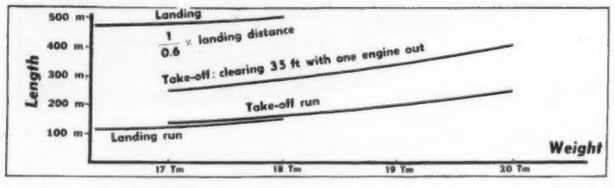
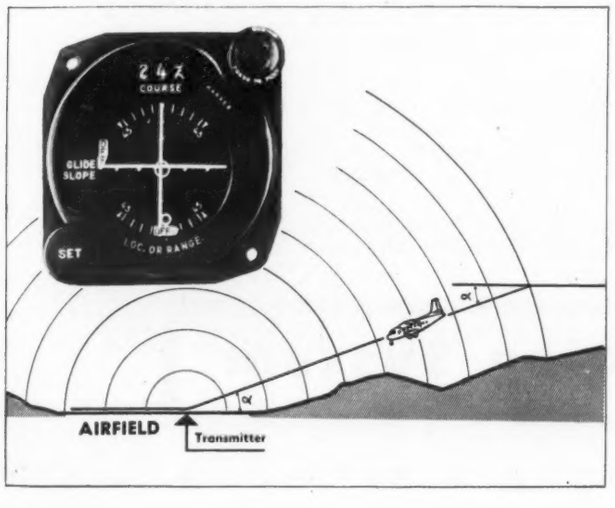






ALL-TERRAIN OPERATION...

The 941 can land on fields without concrete runways. Its special MESSIER " Jockey " undercarriage, with low-pressure tyres, rides smoothly over surface irregularities.

It uses very small fields, for both take-off and landing.

Under present regulations, a runway some 1,650 feet in length and surrounded by obstacles is in all cases adequate for take-off with one engine out and for landing at full load with the normal safety margin.

Its angle of climb and descent is very steep, which enables it to use even the most shut-in airfields, a particular advantage in mountainous country.

IN ALL WEATHERS...

The 941 has a very low landing speed (around 55 knots) and an extremely short landing run.

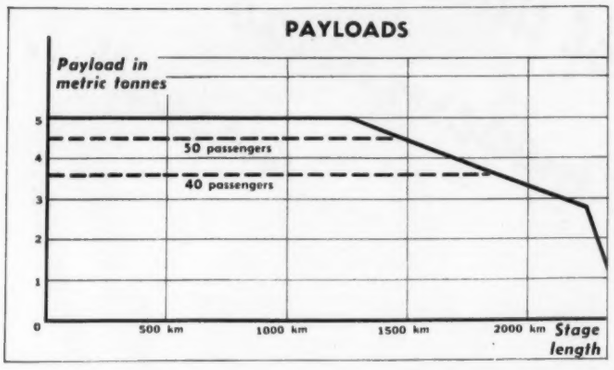
Moreover, its steep angle of descent enables it to use a radio beacon from a sufficient altitude above the field to permit any required corrections to be made in good time.

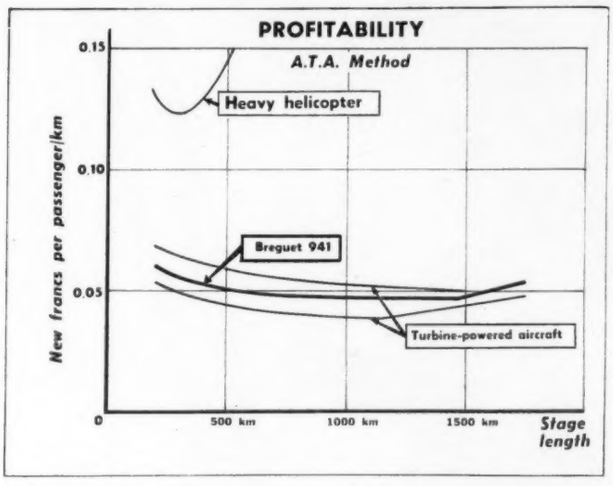
Finally, this steep angle makes possible the utilization of a new, very economical guidance system, whose cost is roughly one hundredth that of an ILS system. This device can thus be installed at any airfield and can guide the aircraft down to the ground whatever the weather.

These features combine to reduce considerably the operating minima, which will spectacularly increase the regularity of this category of aircraft in airline service; this factor is vital on short hauls where competition with surface transport is fierce.

HIGH PROFIT-MAKING CAPACITY

Every possible method of reducing unit cost has been applied in designing the 941.





— The use of ultra-modern manufacturing methods (honeycomb sandwich construction) reduces dead weight to a minimum.

— The capacity of the fuselage enables a very high load in relation to gross weight to be carried on short-range domestic routes.

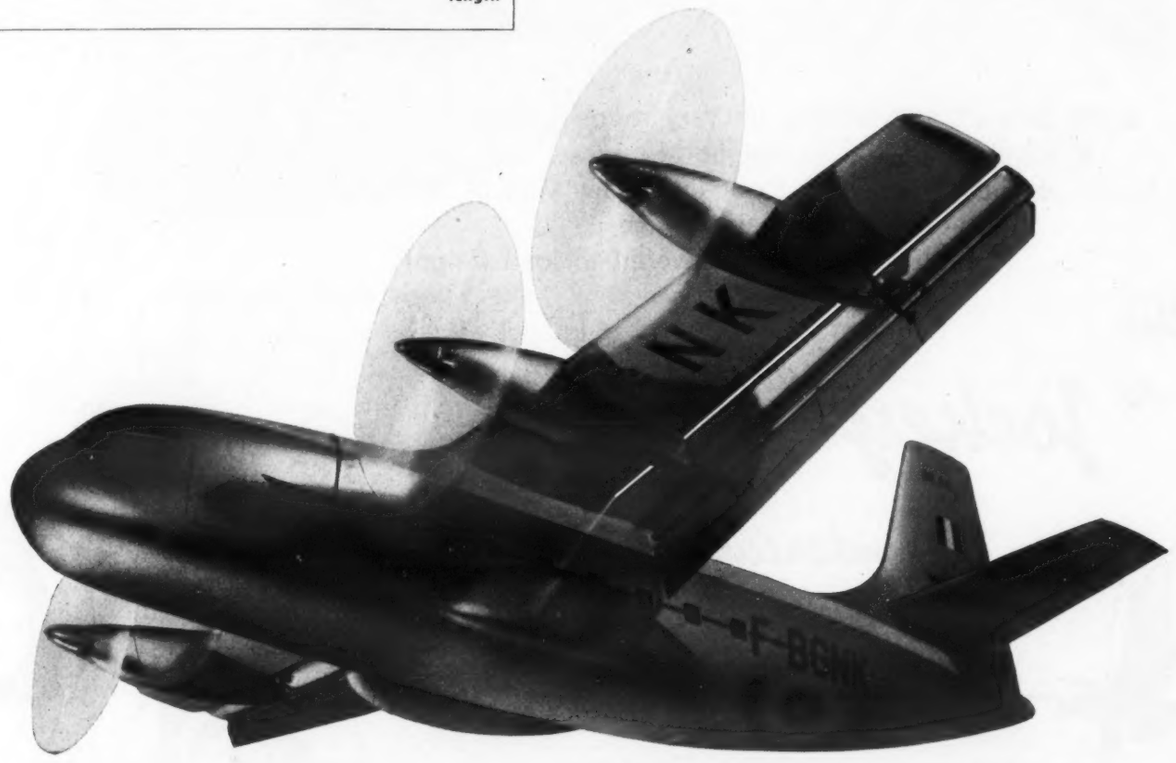
— The fact that the aircraft can be overloaded, depending on the runway length available, enables the same high load to be maintained on stages exceeding 550 nautical miles.

— The accessibility of the passenger and baggage compartments, without auxiliary handling equipment, reduces turnround time at intermediate stops to a minimum.

— Operation from small fields and the high rate of climb reduce the time spent in taxying and climbing, which otherwise substantially cuts block speed on medium stages.

— The sole penalty incurred through the aircraft's short take-off qualities is the cost of maintenance of the transmission system; the latter, however, has been designed for a long fatigue life and adds very little to the general maintenance costs. On the other hand, the power required for short take-off offers, as "by-product," a high cruising speed exceeding 200 knots.

To sum up, operating costs per passenger-mile are entirely comparable to those of conventional turbine-powered aircraft of equivalent weight, and cannot be compared to the very much higher costs of helicopters or compound machines.



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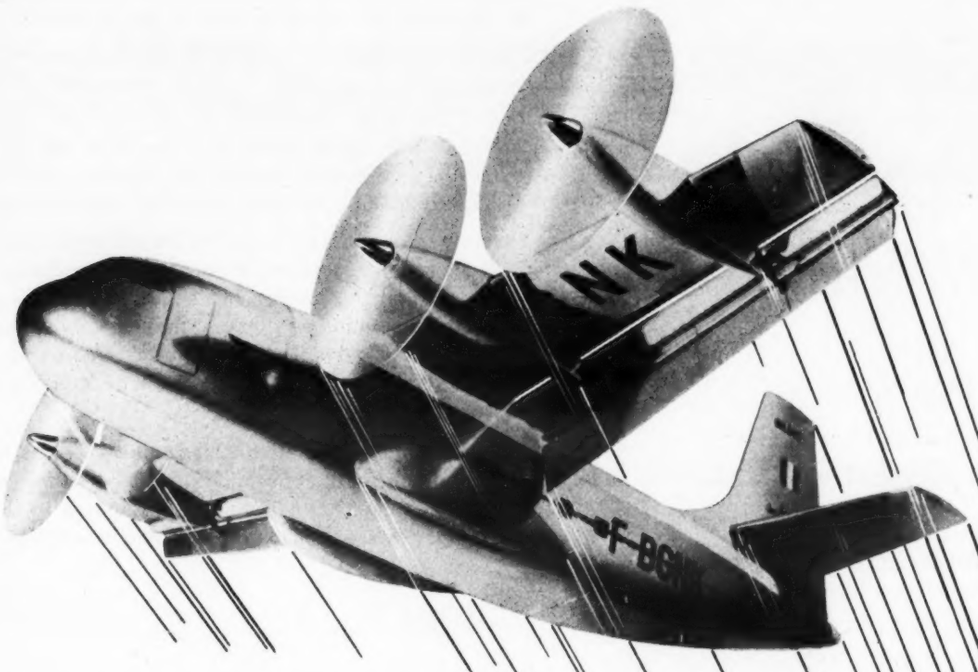

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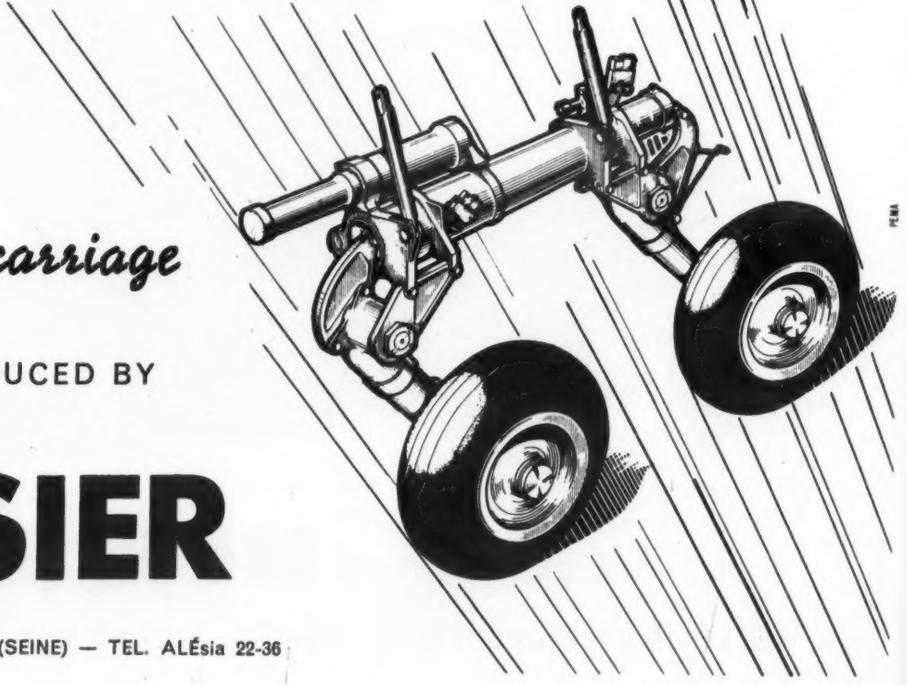
- requires little maintenance
- fuselage can be lowered to load freight

the "Jockey" undercarriage



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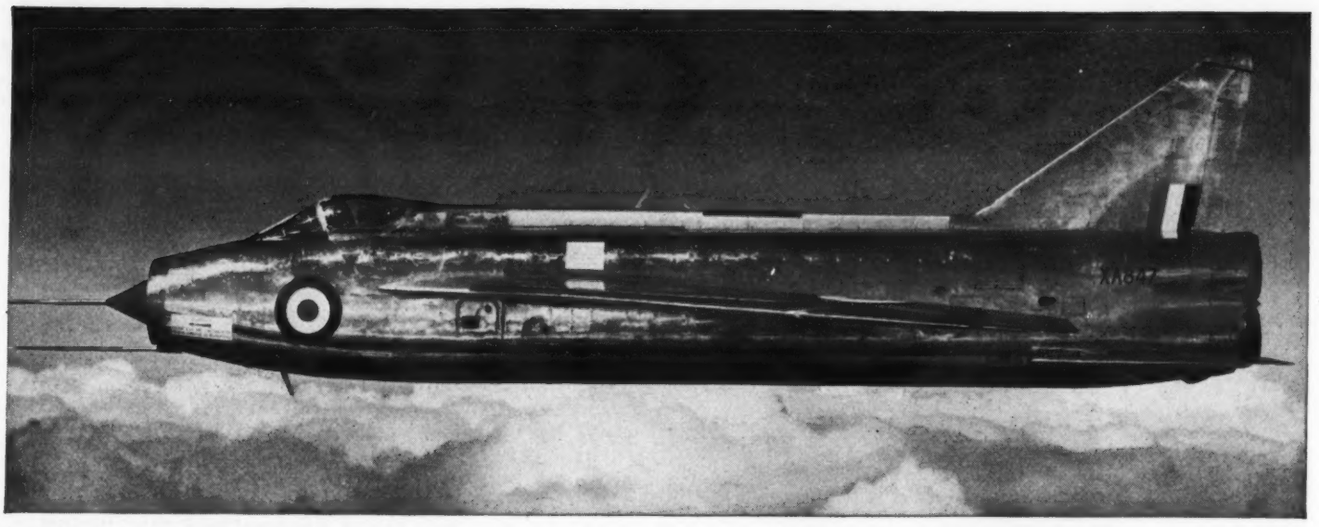

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Controlled Economy in the Ether

Sixty-five years ago Guglielmo Marconi, then 21, made the first radio telegraphic communication near his native town of Bologna when he signalled to his assistant, a young peasant who had volunteered for the job and who was stationed behind a hillock several hundred yards away.

In December, 1901 he succeeded in transmitting the letter S of the Morse alphabet (three dots) across the Atlantic from Poldhu, Cornwall, to St. John's, Newfoundland, 2,200 miles away, where the transmission, though faint, was picked up clearly. Marconi speaks of this as "the happiest moment of my life."

Fourteen years later Bell engineers were sending the first radio telephone messages from Washington, D.C. to Paris, Panama and Honolulu.

Today dots and dashes are flying around the ether in such alarming profusion that one can hardly hear oneself speak; "radio space," like airspace, must be rationed so that frequency bands can be kept free for vital communications, and the experts are looking around in desperation for new ways of compressing transmissions to a minimum, not only in time but also in space, i.e., as regards the necessary bandwidth.

An idea of just what this problem means can be given by a typical case, that of the North Atlantic control station of Gander, Newfoundland, which has to control 120 aircraft at once during peak periods and send or receive one message every 20 or 30 seconds. And Gander is only one of dozens of Atlantic control stations. What is more, apart from messages dealing purely with navigation, such as position, heading, speed and altitude, other information equally vital to air operations—weather, diversions, routine transmissions as aircraft pass over check points etc.—must be passed. In addition, the commercial services of the airlines send their requests by radio (seat reservations etc.). Finally, it should be remembered that not only aviation, but also shipping and the postal, telegraph and telephone services are all concerned to get as large as possible a slice of a very small cake. Small wonder that the delegates at the International Telecommunication Union Conference in Geneva at the end of 1959 were puzzling for weeks over the future of radio waves. Nor is it surprising that those responsible for air traffic control planning are anxiously asking themselves what will happen to communications in the years to come if air operations continue at their present rate of growth.

These problems of congestion in the ether have led the editors of *Interavia* Review to choose the field of *telecommunications* as one of the main themes of the April issue and present readers with a survey of the equipment, systems and procedures which the world's electronic engineers are devising to bring radio in aviation to jet age standards.

The first article reviews the present situation as regards the various frequency ranges and suggests that the only solution, as far as voice radio is concerned, is a standardized speech pattern clothed in "electronic uniform."

In the long run, however, voice radio will certainly have to be abandoned, since the mellow tones of human speech, evolving as they did in a more leisurely age, are far too long-winded for the concise formulation of prosaic routine messages. Agreement will have to be reached, as has already been done for hotel room reservations, on a few code terms, and we shall finally have to descend to the level of the robot, whose entire vocabulary consists of the ciphers *zero* and *one*.

Another advantage of such "symbolic" speech would be that it would reduce the risks of misunderstandings due to individual voice peculiarities or language difficulties. How urgent such measures have become has been shown by certain accidents to aircraft in South America, which the experts have attributed, at least in part, to the air traffic controllers' imperfect understanding of the English language. Until symbolic speech is introduced the only way out of the dilemma is a strict discipline in voice radio communications—"But let your communications be yea, yea; nay, nay: for whatsoever is more than these cometh of evil." And discipline should be maintained not only in voice communications, but in flight operations as a whole. Even military aviation will have to abandon some of its wilful ways and fit itself into the overall pattern of air traffic if human lives are not to be recklessly endangered.

*

So much for telecommunications. In addition, the April issue continues the series on the single-seat combat aircraft with a detailed description of the Dassault *Mirage III*. Another theme of great topical interest is the sudden upsurge of the German aircraft industry after years of irksome preliminaries. *Interavia's* observer, back from an extensive tour of inspection through West Germany, was impressed by many aspects of the German programme: with maintenance contracts covering 2,500 military aircraft and orders for the licence production of almost 1,000 modern combat aircraft and transports, the lines along which the German industry is to develop during the coming years seem—both technically and economically—well assured.

As for the French and British industries, at the beginning of March they recorded a success which is of decisive importance for the development of the aircraft industry throughout Europe. United Air Lines, one of the "Big Four" in American air transport, has placed a $65 million contract for 20 SE.210 *Caravelle* medium-range jet airliners and is to equip this fleet with Rolls-Royce *Avon* engines. Thus Europe is once again playing the role of supplier to American civil aviation. The capital invested in the European aircraft industry since the war is beginning to pay handsome dividends. **

Electronics

New Radio Communications for Aviation

By W. Stanner, Feldafing, Munich

Hundreds of millions of passengers, flying times cut in half, intercontinental aircraft with 150 seats... We have become so accustomed to speaking of air transport in terms of records that less spectacular achievements have been pitilessly thrust into the background. Among these stepchildren of publicity are air-ground communications. In the heroic days of pioneering, aviation managed without any kind of radio communications, and many a pilot who has grown grey in airline service must long for a return to the good old days. It would be quite unthinkable, however, to cope with the present flood of traffic without radio communications. Owing to the increased numbers and speeds of aircraft, airspace has become scarce, and airports, in particular, are dangerous bottlenecks to air traffic. A meticulous preparation of flight plans and a stricter control of the flow of traffic are indispensable if full advantage is to be taken of the progress achieved in airframe and engine construction.

But for these tasks it is necessary to allocate frequency channels, which are in all too short supply. Only after laborious studies and by working out many compromises did the world's radio experts, meeting in Geneva in December last year, reach agreement on new radio communications regulations applicable to all services. Any unilateral alteration of the Geneva resolutions would inevitably result in hopeless chaos in the ether.

Indeed, air-ground communications procedures would today be in a dangerous impasse, had not every effort been made to take account of future air traffic requirements. Economic and financial circles are, however, more sympathetic to demands for higher flight speeds and increased carrying capacity than to requests for the procurement of new aids to communication or navigation. The "black boxes" are relegated to a "backstairs" position and are, at best, grudgingly conceded a modest place at some inaccessible spot in the fuselage; under no circumstances, however, must a passenger seat be sacrificed to accommodate them.

For this reason it cannot too often or too emphatically be stressed that all new developments in the field of electronics should be made available to aviation in good time and under long-term equipment programmes.

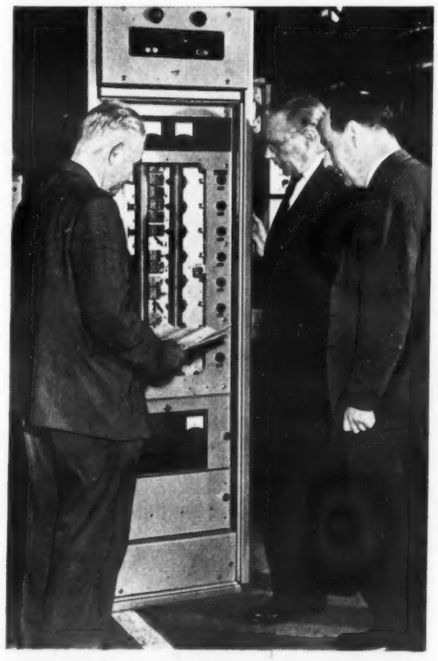
Fundamentally, the problem is to find the most rational way of transmitting to the control station such data as position, speed, heading and altitude. By comparison with other equipment at airports and airfields, the methods in common use today are hopelessly antiquated. The exchange of information by voice radio may be quite satisfactory on land and sea, but the same equipment and procedures, however efficient, are completely out of date when applied to flying in the jet age.

Various studies in connection with the information theory show that the *theoretical optimum bandwidth* for voice communications—this case is of especial interest—is about 100 to 200 c/s. Here a flow of about 60 information units is exchanged every second. But the speech channels normally used in radio communications carry several thousand information units per second. This is, of course, far in excess of requirements, for the wide variety of individual inflections in human speech occupies about twenty times the theoretical minimum bandwidth. Unfortunately, however, the problem cannot be solved simply by narrowing the limits of the voice band, as this impairs the clarity of individual syllables. It is preferable, by the use of filters and electronic conversions, to deprive speakers of their personal speech characteristics, putting, as it were, their messages into "electronic uniform" and evolving a standardized speech pattern which would, nevertheless, be different for each language. The feasibility of such a system has already been demonstrated experimentally, so that our frequency band problems could be solved in an appreciable degree, though with the penalty of increased equipment.

But we shall still probably have to wait about ten or twenty years to see the introduction of equipment which will provide us with a "robot language." However it may be opposed by airspace users, this will ultimately be the only way out of the dilemma caused by the growing shortage of bandwidth. As it is, present voice communication methods are hardly different from those used many years ago.

The following paragraphs survey some of the equipment and procedures suitable for use in aviation and operating on various frequency ranges. The MF band has not been dealt with, since its applications in this field are limited.

The majority of long-range air-ground communications are carried out in the HF band. The Marconi 1 kW transmitter Type HS113 is illustrated here. This revolutionary new equipment is capable of transmitting on two or more entirely different wavelengths simultaneously, and dispenses with the need for tuning controls in the HF amplifier stages.



The VLF/LF Band

For years the potentialities of the low-frequency range were eclipsed by the impressive progress made in the short-wave field. Admittedly, the number of transmitters capable of working in this band is very limited, but the few stations which are in operation make it possible to achieve *long-distance communications of exceptional reliability*. It appears that the space between the earth's surface and the lower limit of the ionosphere enables long waves to be propagated with a negligible degree of attenuation, as in a giant waveguide. It is also interesting to note that these waves undergo only limited absorption by water. Excellent long-distance communications can be maintained even with submerged submarines, as the layer of water above the submarine insulates it from random atmospheric noise—a phenomenon which can be explained only by complicated theoretical studies. Recent investigations have dealt with propagation phenomena earlier neglected, in which the propagation path along the lines of the earth's magnetic field plays a decisive role. A U.S. Navy experimental station at Annapolis is conducting research into these phenomena on a frequency of 15.7 kc/s.

Thus long waves offer various means of ensuring reliable world-wide communications with all fighting forces on land, at sea and in the air. Moreover, it is possible to operate transmitters for very long distance navigation on these frequencies, and some channels are available in the 10 kc/s and 100 kc/s bands. No agreement has, however, yet been reached as to the procedure to be used in such operations.

The HF Band

As the majority of long-distance communications pass over the HF band, the channels available are already inadequate in many regions, and similar situations are likely to arise in other areas before many years have passed. The desire to make better use of the available channels is therefore universal. Fortunately, a way has been found to relieve the congestion in this frequency band. Most HF communications are still carried out with the aid of amplitude modulation, where the carrier is always radiated at a constant strength, regardless of whether the transmission is modulated or not. Only with modulation do the two sidebands lying symmetrically at each side of the carrier appear, and it is well known that this method involves a waste of transmitter energy and bandwidth. Irrational as it is, the procedure has one major advantage: an amplitude-modulated transmission can be reliably picked up with even the simplest of equipment such as, for instance, a detector. For the some 300 million domestic radio receivers at present operating throughout the world, amplitude modulation is, for the time being at any rate, the best that has been achieved for long-distance reception. But the circumstances are quite different for commercial long-distance communications. Here—and this applies particularly to propagations via the ionosphere—fading phenomena occur, which have different effects on the carrier and sideband frequencies. This is known as "selective fading" and causes shifts in the normal phase/amplitude relationships of incoming signals. For those receiving the message these shifts take the form of appreciable distortions. Thus, where long-distance communications are concerned, selective fading disrupts the dual sideband reception which is so popular with radio users. The situation can, however, be remedied by a different form of modulation in which only one sideband is radiated. Here the carrier is either entirely suppressed or else reduced so that only a small portion of it remains. Distortions due to fading are thus eliminated; moreover, the number of channels can be doubled and range increased.

Single sideband modulation is by no means a new discovery. As early as 1923 experiments were made between stations in Britain and the United States, when a 300 to 3,000 c/s band was converted to a 55.8 to 58.5 kc/s band and radiated. This system subsequently found wide application in long-distance telephony. Here, by international agreement, twelve channels, each 4 kc/s wide, operate side by side in the 6 to 54 kc/s band. Five basic groups of channels, making a total of 60, are contained in the 12 to 252 kc/s band. The bands then pass through a carrier-frequency cable or (via a modulator) through a radio link. This

Decca/ Dectra Data Links

A lightweight Type 860 Decca Display Head installed in a BEA *Comet 4B*.

Development work has been in progress for some time on the principal elements of a data link to be used with the Dectra System. A comprehensive system is envisaged that will handle some 200 aircraft. The data will be transmitted in terms of a digital code, in the form of audio tone modulation of an HF carrier. Given an accuracy requirement of 1/64 zone in the tracking coordinate and ¼ zone in ranging, the fix will be expressed as 11 digits for tracking and 12 for ranging. Extra digits will be transmitted to give information on aircraft altitude and on aircraft identity, the number of digits required for the latter information varying widely, depending on the type of identification required. The maximum rate at which a digital signal can be transmitted for distances such as those involved in the North Atlantic Dectra chain, will be limited by "reverberation," i.e. by the arrival of signals via modes of propagation other than the one required; subject to results of trials, the safe limit is estimated at 20 dots per second. A message giving an aircraft's position, height and identity will occupy approximately 2½ seconds, allowing a 4 : 1 redundancy factor in the interests of reliability. A selective calling technique will be used, by which 12 aircraft could be handled each minute. Allowing a margin of guard time, about 20 minutes would be required to handle the full 200 aircraft in the unlikely event of only a single carrier frequency being available. A marked reduction in delay would obviously result from the use of a multiplicity of channels. The principle of the Dectra data link could, of course, equally well be applied to the shorter-range Decca Navigator system.

Concurrently with the present practical work on the data link itself, thought has been given to various aspects of the ultimate display and traffic control system of which the links form part. Factors under consideration include the automatic detection and display of collision courses as one of the functions of the central computer; the prediction of the future positions of aircraft in a given height band and the speeded-up visual display of, say, the next 15 minutes' traffic on this basis; the handling of the data on specific categories of aircraft, e.g. those in a given height band or belonging to a particular airline; and the storage of all the incoming data in such a manner that the traffic situation for any given period can be visually played back for purposes of statistical analysis and investigation.

Decca information transmitted from air to ground over a data link of the type just described may take the form either of the two hyperbolic coordinate values constituting the position fix, or another pair of figures defining the aircraft's position in a more directly usable form. In the first case, the process of reducing the hyperbolic fix into terms suitable for display and handling for ATC purposes would be carried out on the ground by an electronic digital computer. The transformation of hyperbolic coordinates into eastings and northings, or into latitude and longitude, presents no fundamental difficulty, and an electronic computer has been used for several years past for the closely-related process of constructing hyperbolic lattices overprinted on maps of conventional projection.

There may, however, arise a requirement for receiving the data on the ground (and possibly in other aircraft) in an "undistorted" form, i.e. for carrying out the coordinate transformation in the aircraft. This is, in fact, one of the functions to be assigned to the Decca lightweight airborne digital computer which is now at an advanced stage of development. The principal purpose of this computer is to permit the use of Flight Log charts which are wholly free from the distortion of the type associated with the "inverse lattices" at present employed; in addition, the transformation of the Decca coordinates into rectilinear terms greatly facilitates the integration of the system with other radio aids such as Doppler and inertial devices, and permits the direct coupling of Decca with an automatic pilot with complete flexibility. The problem has been that of combining in such a computer the attributes of high reliability, high accuracy, small size and reasonable cost. Striking progress has recently been made towards a satisfactory solution, and a prototype computer will be flying during the summer of the present year.

Automatic Communications Equipment

The current development of data link systems which automatically report flight progress in terms of position, altitude and heading is paralleled by research into automated communication systems.

In commercial transport operations a large proportion of the signals traffic between the aircraft and traffic controller is of a routine nature. Similarly, with successive aircraft in the traffic pattern, the message content is largely repetitive. Aircraft report at designated points, request clearances at specified regional boundaries, and acknowledge instructions in a standard pattern.

With the best of radio discipline and the utmost brevity in the messages, this amount of traffic occupies considerable time when handled verbally. The use of extra channels to speed up the process is unsatisfactory because of the shortage of available frequencies. To obviate these difficulties, the development of automatic communication systems using pulse trains to transmit information is well advanced, and the Radio Corporation of America is at present carrying out field trials on an automatic ground-air-ground communications system (AGACS, pronounced "Ajax"), which is being developed for the Federal Aviation Agency.

The object of the system is to relieve both pilots and air traffic control operators of the necessity for oral conversation about routine flight information. Any one of 32 predetermined messages can be transmitted by either the pilot or controller setting a dial to the desired message number and then pressing a button. In operation only a quarter of a second is required for a routine two-way exchange of information with each aircraft, and one ground control point can be in touch with as many as 500 aircraft in its area at least once every two minutes, using a single frequency channel.

As the system is still undergoing development, the message contents have not yet been finalized. In operations it will be a simple matter to establish the routine messages in relation to each route and feed them into the system.

The automatic communication system handles three types of operations: the routine roll-call, controller-initiated messages, and pilot-initiated messages. In the first type, the ground equipment sequentially interrogates the aircraft in the area, whereupon the airborne equipment recognizes the ground/air interrogation and automatically reports the present altitude and passes any routine reports. This is carried out without any intervention from the pilot. In the case of a controller-initiated message requiring the pilot's attention, the message is entered into the system by the controller's handset and transmitted in place of the roll-call message or in any priority at the controller's option. The message is then automatically repeated until acknowledgement is received from the pilot. In the air the equipment recognizes the address and displays the new message on the panel for the pilot's attention. The operation for a pilot-initiated message is similar. The ground equipment recognizes the message and alerts the controller, while the airborne equipment continues to repeat the message until acknowledgement is received.

The following items are illustrative of the basic kinds of routine air traffic information handled by AGACS. The ground-to-air messages would include such items as flight clearance data, advisory information, controller instructions and acknowledgements. At the same time the equipment would carry out its continuous roll-call interrogation automatically. Traffic in the air-to-ground direction would consist of flight progress reports, flight plan estimates, clearance and advisory requests and acknowledgements. Similarly, the airborne equipment would automatically respond to the ground interrogation, reporting the aircraft's identity and altitude.

As the content of the 32 preset messages can be easily adjusted to suit the requirements of the routes on which the aircraft is operating, and time checks are transmitted automatically with each message, the system is adaptable to the requirements of all airspace users. In operation its advantages will be manifold. The increasing cruise speeds which are becoming commonplace in today's commercial transport operations have the effect of increasing the workload in the cockpit. The elapsed time between reporting points is reduced, and the need for frequency changes to communicate with successive control points becomes more common. With an automated communication system this workload is sensibly reduced. The aircraft are rapidly interrogated in succession for communication, and the transmission is completed in a fraction of the time required for oral transmission. This means that a greater use can be made of the frequency spectrum, and voice communication can be carried out, if necessary, with less possibility of interference and the necessity for repeats. It is becoming increasingly apparent that such an automated system will be a necessity on the crowded airways of the future.

Airborne display equipment for the AGACS system at present undergoing development by RCA.

example unambiguously shows the rational use to which the transmission channels can be put. Similar considerations hold good for aircraft radio applications, though the carrier frequencies here are considerably higher.

The advantages of single sideband (SSB) operation cannot, however, be obtained without effort. In order to recuperate one speech band it is necessary at the receiver to produce an oscillation of the same frequency as the carrier which has been suppressed at the transmitting end. As the carrier is no longer contained in the radiated band, it must be reproduced. The necessary high stability of the added frequency is easier to achieve in telephony than in radio operations. However, operational SSB equipment is available today, particularly in military aviation. Here SSB operations have yet another advantage in that the absence of the carrier frequency in transmissions make it more difficult for an enemy to listen to or jam them.

The VHF Band

By comparison with lower frequency bands, the VHF band is of such vast dimensions that earlier worries as to congestion have been greatly reduced. The adoption of *frequency modulation*, which is a general practice in this band, permits operations at constant amplitude and enables better use to be made of the last stage of the transmitter. The receiver remains above the noise level, so that good, interference-free communication is maintained. Miniaturization and the extensive use of transistors make the airborne equipment compact and easy to handle. The receivers are frequently combined with additional equipment for VOR and ILS procedures, and this combination is likely to remain unchanged in its basic features during the coming decade.

The current rate at which radio communications are conducted must, however, be qualified as sluggish by comparison with the aircraft speeds which can be reached at the present day. As, in the normal way, the problem is simply one of transmitting data in a sequence which is virtually constant, there would appear to be a case for at least *partial automation*. Both air and ground personnel would be freed from the necessity of sending and receiving messages themselves, and their task would be limited to feeding in data or confirming and evaluating them. The ground station would maintain contact with each aircraft for only a fraction of a second as, for example, in the case of one such system, where the figure is 0.24 sec. In this way channels can be put to far greater advantage. All users of a system of this kind can, of course, pass a communication only at fixed intervals. In cases of emergency, however, the time-allocation system can be overridden. For the moment reports are processed both in the air and on the ground by the operating personnel, but at a later stage of development this procedure, too, will be fully automatic.

Normal VHF voice radio enables the communicating station to be rapidly located. The manual direction-finders formerly in widespread use are mostly being replaced by fully automatic ones. The bearing line can be switched into the air traffic control radar situation display and enables

A typical set of lightweight VHF communication and navigation equipment manufactured by Collins Radio Co. Left to right: 17L-8A Transmitter, 51X-3 Receiver, 344D-1 VOR/LOC Indicator, Power pack and 51Z-2A Marker Beacon Receiver. *Right:* The positioning of the antenna and the subsequent radiation pattern plays an important part in ensuring satisfactory communications. This antenna pattern range at the Wichita Division of the Boeing Airplane Co. is suitable for low to super-high frequency testing and allows full freedom of pattern measurement in any attitude.

the echoes on the screen to be better identified. Ideally, special identification equipment should be available for this purpose, but such systems have not yet been introduced into civil aviation on a widespread scale.

For some time it was thought that VHF/UHF waves were limited to line-of-sight range. It has since been discovered that there is, beyond the horizon, a *residual field strength* whose average value—depending on distance—lies from 40 to 80 dB below that of free propagation in space. Now that there are available high-performance transmitters, sufficiently sensitive receivers and aerials with gains of 45 dB and above, residual field strengths can be used for long-distance communications in *scatter systems.*

Long-distance "over-the-horizon" communications can also make use of the ionization trails of meteors. Meteors of all sizes enter the upper atmosphere at speeds of 6 to 45 miles per second, become heated and vaporize. In their path they leave an ionized trail several feet wide and between 6 and 12 miles long. For radar tracking purposes, the backward scatter from meteor trails is normally used, while the far stronger forward scatter can be utilized for signal transmissions—though only during the period of ionization. The data for transmission are prepared in stored form, preferably by the punched-card method. An advantage of this system is the very slight risk of the message's being overheard by third parties.

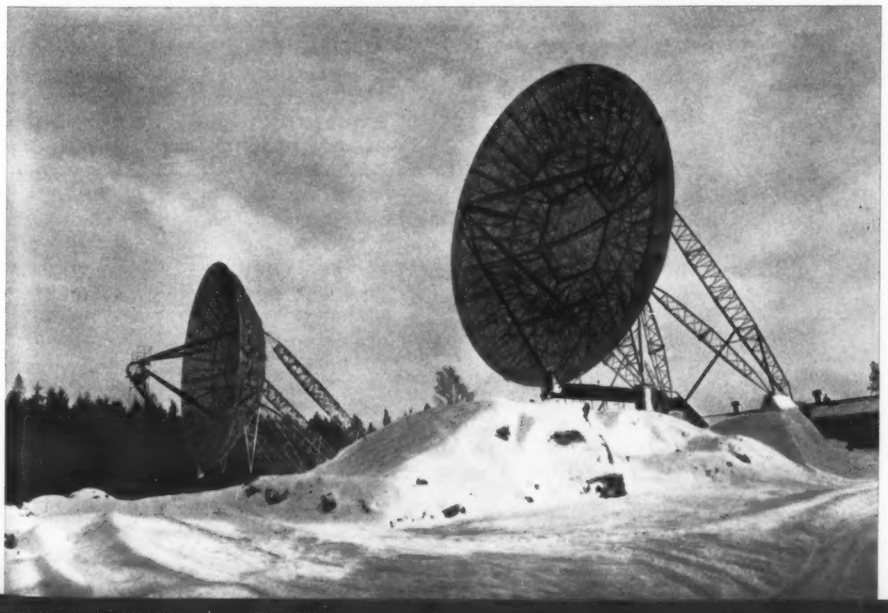
Extraterrestrial Communication Stations

In recent years artificial satellites have used VHF channels for telemetry and tracking. The energy for the transmitter, which often has to run for years on end, can be supplied by solar cells. It is therefore hardly surprising that people have had the idea of using satellites as *relay stations* for communication purposes. A first attempt along these lines was made on December 18th, 1958, when a satellite was launched by an *Atlas* booster under Project *Score.* The satellite's equipment picked up messages from the earth, stored them on magnetic tape and beamed them back again upon interrogation.

Passive communications satellites in the form of balloons with a very fine aluminium skin and a diameter of about 100 ft, are to be put into orbit during 1960. *Active satellites* will follow later on. In order to be really effective as relay stations, satellites must be fired to great heights and have long orbital periods. Fortunately, both these requirements coincide. Since radio field attenuation (loss of energy between transmitter and receiver) reaches very high values, all technical means of improving the performance of transmitters, receivers, and antennas must be utilized to the full. It is therefore likely to be many years before the much-discussed three or six satellites will be able to take up their duties on their 24-hour orbit around the earth. The equipment which it will have been possible to develop by that time will, however, be powerful enough to ensure reliable communications with space vehicles travelling to the vicinity of Mars or Venus.

The Marconi Automatic Fixer presents bearings of the transmitting aircraft and thus permits rapid identification on the radar display.

Transmitting and receiving aerials for a UHF forward scatter communications station operated by NATO in Norway.



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In conclusion, passing mention should be made of the use of the moon's surface for passive relay. The experiments made to date, particularly those between the USA and Hawaii and the USA and Great Britain, have shown that radio magnetic field attenuations can be as much as 250 dB. For communications via the moon, therefore, transmitter power must be 10^{25}—i.e. 10 quadrillions—higher than the minimum input energy required by the receiver to operate above noise. The successful transmission of speech and picture signals during recent months has shown that it is possible to achieve even such enormous values as these.

Electronics

Correcting the Inadequacies of Long-Distance Air-Ground Communications

By E. W. Pappenfus, Collins Radio Company, Cedar Rapids, Iowa

E. W. Pappenfus is a leading authority on single sideband communication systems today, and in his present position as Director of Development, Division A, Cedar Rapids, he has directed the research and development programme of Collins Radio Company in this field. Eds.

It has been ten years since the International Administrative Aeronautical Radio Conference arrived at channel allocations in the high-frequency band for aeronautical mobile use. This organization, under the auspices of the International Telecommunication Union, was given the assignment to deal with the exclusively aeronautical mobile service bands. Fifty-six member nations took part in the conferences, which resulted in the assignment of 248 channels, spread over 1,990 kilocycles of the high-frequency spectrum. In the ten years since the frequency channel allocations were made, the number of passengers carried on international routes has multiplied by a factor of almost five. This is particularly evident in the North America to Europe routes over the North Atlantic. There are approximately 100 commercial flights daily, and at one peak period 120 flights were present simultaneously in the Gander Newfoundland Control Area. With ideal spacing of communications from these aircraft, there would be an average of one air-ground communications interchange every twenty to thirty seconds. Repeats, interference and poor propagation conditions at times delay ground acknowledgement for 20 minutes or more. Gander, for example, has a total of 13 communications channels available at approximately 3, 6, 9, 13 and 18 megacycles. Experience has shown that approximately 50 percent of the traffic is handled on the channels near 6 megacycles.

Because so much of the radio traffic is concentrated on a few channels, an unexpected density of air-ground transmissions results. Since Gander is the principal oceanic control, it is imperative that reliable and fast communications be available for all aircraft operating in that area. Usually, amplitude modulation provides satisfactory communications; however, under disturbed conditions it falls far short of what is required to provide proper air traffic control in the area.

Surprisingly enough, under excellent propagation conditions traffic handling again is difficult, because all stations and aircraft in the North Atlantic circuit can be heard, whether near or far, and severe interference results. It seems apparent that three factors are required to improve the status of air-ground communications over the North Atlantic. One, a more effective communications system must be provided. Two, more radio frequency channels must be made available within the aeronautical mobile band allocations. Three, better discipline on the communications circuits must be obtained. A more effective communications system can be obtained by using more transmitter power, a more efficient antenna or a more effective modulation system. More radio frequency channels are not likely to be assigned because many other services are clamoring for a larger share of the high-frequency spectrum. The aeronautical mobile users will be fortunate if they retain all of the existing channels. In lieu of additional new channels, more effective use of the available 1,990 kilocycles must be made. If a more effective communications system and more usable channels are made available, then better discipline can be expected. It is the irritation and frustration of a pilot unable to call up a ground station that often leads to unintentional bad operating practices and interference.

A change from amplitude modulation (AM) to single sideband (SSB) transmission and reception will greatly improve communications under disturbed conditions and also will provide many more radio frequency channels. This change cannot be made without the expenditure of a considerable amount of money and effort, but the results will be well worth the expenditure. The reduction of bandwidth possible when changing from amplitude modulation (double sideband) to single sideband is illustrated in *Figure 1*. The channel frequency (frequency of the carrier wave) is assumed to be 4 Mc/s. By means of a suppressed carrier single sideband transmitter, either the upper or the lower component band of frequencies in the corresponding AM signal can be radiated. This halving of the signal can be accomplished without the loss of any communications effectiveness. Actually the reduction in bandwith is accompanied by several advantages, as will be discussed later. With the 1,990 kc/s of available spectrum assigned to aeronautical mobile radio, it would be possible to increase the 248 channels now available on an AM basis to 496, assuming

Fig. 1: Comparison of the bandwidth required for amplitude modulation voice communications in the 4 Mc/s band (above) and for single sideband transmission (centre and below).

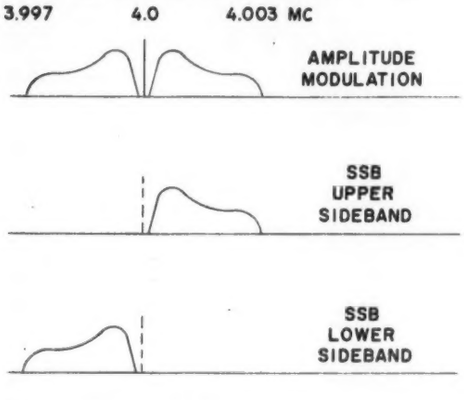


Fig. 2: Portion of the HF band for ground-to-air communications for amplitude modulation (above), single sideband (centre) and amplitude modulation with frequency error (below). Frequency in kc/s.

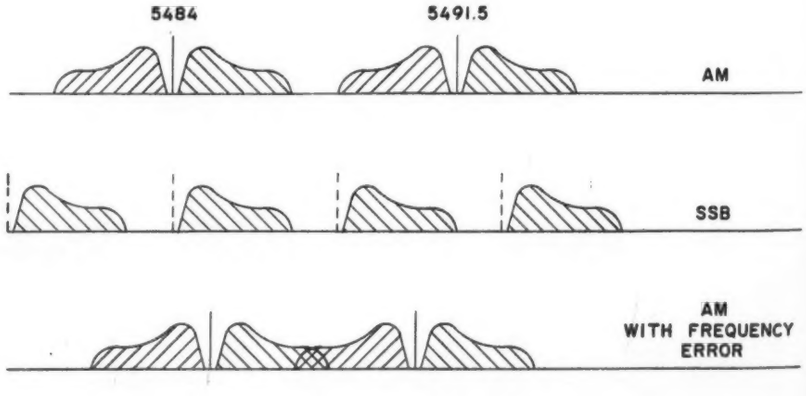


Fig. 3: AN/ARC-58 airborne transceiver (HF SSB) for 1,000 watts in SSB operation and 250 watts in amplitude modulation. Left to right: pilot's control, power amplifier, receiver-exciter, antenna coupler control, antenna coupler.

Fig. 4: Pilot's control for AN/ARC-58 showing selector switch (AM, upper, lower or both sidebands) and direct reading frequency dial controlled by four knobs.

a 4-kc/s channel spacing with single sideband. This two to one improvement in the number of channels which can be assigned within the existing aeronautical mobile service bands will relieve the problem of alloting new frequency channels to those control areas in which high traffic density occurs. The two to one improvement is conservative, since a *larger guard band* is assumed between channels than was assumed for the AM assignments.

The gain in assignable channels can be seen in *Figure 2.* Two AM channels are shown in the 5,480-kc/s band. These are typical of 31 more that extend to 5,730 kc/s. A possible SSB channel assignment is shown for comparison. A one-kilocycle guard band is shown between each voice band. The result of frequency error in transmission for the two AM channels is a small amount of overlap. The guard band in the AM assignments is insufficient to prevent some interference between the high-frequency modulation components. In SSB, the frequency stability is within one part per million, or about five cycles at the frequency indicated. This is not enough to show in the frequency scale of the figure. To place this frequency stability, readily obtainable in present day radio apparatus, into perspective, it is possible to make a geographic comparison. One part per million error is the same as a twelve foot error in measuring the distance between Gander and London.

The United States Air Force has taken the first great step toward implementation of single sideband. The U.S. Air Force is making use of the AN/ARC-58, manufactured by the *Collins Radio Company,* and the AN/ARC-65, manufactured by the *Radio Corporation of America.* Over two thousand aircraft are now equipped for SSB in the USAF. These two airborne, single-sideband transceivers provide high power, suppressed carrier single sideband with inherently high frequency stability. The Air Force maintains compatibility with existing ground stations by providing both single sideband and amplitude modulation transmission and reception in their transceivers.

Single sideband removes much of the power in the carrier and eliminates one of the sidebands. Not only does this method of modulation reduce the frequency band required for transmission, but it also saves a considerable amount of power, since the carrier and one sideband are not transmitted. The required bandwidth, which is just one-half that required for amplitude modulation, permits a narrowing of the corresponding receiver bandwidth, so that the receiver has greater immunity to interfering signals. Many tests have shown that single sideband transmission does not suffer from the distorting effects of fading which are common with amplitude modulated transmission.

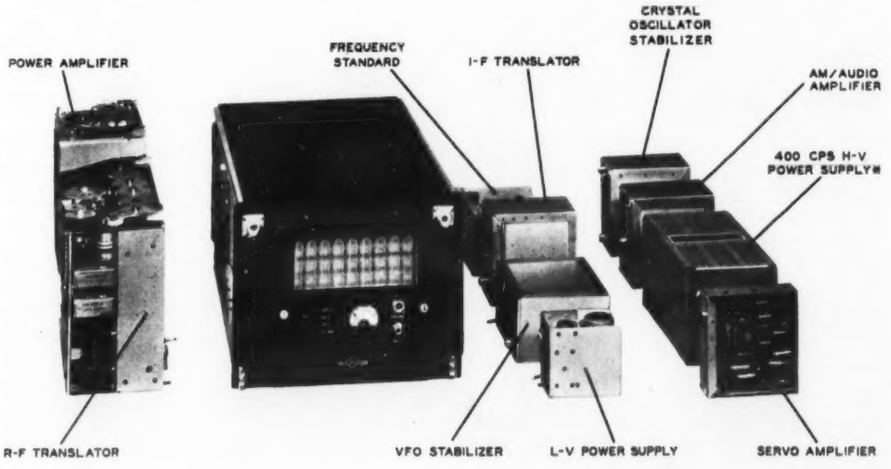
Single sideband has been used extensively in point-to-point service for twenty-three years. The telephone company in the United States, and the communication departments in a number of other countries such as Great Britain and the Netherlands, found that the only reliable communications that could be provided over long distances in the high frequency bands were by single sideband pilot carrier transmissions. These circuits make use of high power transmitters and directive antennas to provide reliable extensions of land telephone circuits. There was no great incentive to reduce the size and weight of the equipment used for point-to-point service since extra bulk and weight are not a disadvantage in ground based equipment. For a long time, it appeared unlikely that single sideband transceivers could be built that would combine the desired frequency stability with the small size and weight requirements characteristic of airborne communications apparatus. Recent developments in miniaturization and the development of a small airborne frequency standard contribute to the successful design of a number of airborne single sideband transceivers. Commercial aviation has recognized that SSB is not far away. *Aeronautical Radio, Inc.**, through the *Airlines Electronic Engineering Committee,* has approved Characteristic 533 for a single sideband transceiver.

*

For proper detection of single sideband, a carrier must be reinserted at the receiver that is within 50 cycles per second of the corresponding carrier in the transmitter. This imposes a requirement for much greater frequency stability on SSB systems if the carrier is reduced to a negligible value than is required in AM systems. In the past point-to-point telephone applications, the need for such precise frequency control was avoided by applying an automatic frequency control circuit to the receiver that locks to a reduced carrier single sideband signal to control accurately the frequency of a receiving oscillator. While frequency control by an accurate standard is somewhat more difficult to obtain, it has the advantage that drift of channel frequency is not sufficient to cause interference, as shown in *Figure 2.* Tests of SSB systems by a research team at Montana State College showed that error in the reinserted carrier of as great as 200 c/s did not render the channel unintelligible. In fact, the number of words that could be identified in a message at 200 c/s error was sufficiently large to make communications effective. Arinc Characteristic 533 requires a frequency accuracy within 20 c/s, which is slightly less than one part per million error. The use of reduced carrier SSB and automatic frequency control in the receiver will reduce frequency errors to zero. Arinc Characteristic 533 asks not only for accurate frequency

* Aeronautical Radio, Inc., nicknamed ARINC, is a corporation owned and operated jointly by airlines in the U.S. to provide communication service, establish airline equipment standards and conduct research in the field of reliability.

Fig. 5: 618T-1 airborne transceiver for 400 watts in SSB operation and 100 watts in AM operation.



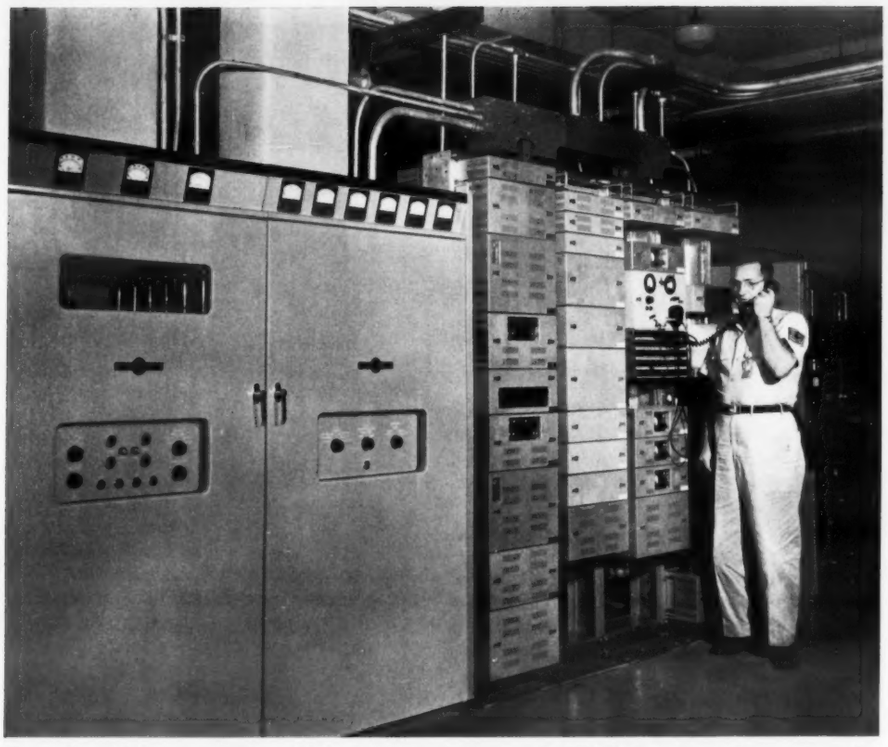


Fig. 6: For global communications with its bombers and transports the USAF's Strategic Air Command uses this Collins single sideband ground station of 45 watts output power, with 28,000 channels in the 2 to 29.999 Mc/s range.

Fig. 7: A Collins station used by SAC for point-to-point communications. It also works in the 2 to 30 Mc/s range with 1 kc/s channel spacing and 500 watts output power.

control adequate to assure proper voice operation with suppressed carrier, but also specifies that the equipment must be capable of adding an auxiliary unit for automatic frequency control. The auxiliary unit can be added at some future date to secure the frequency accuracy that might be needed for certain types of data transmission. Not all data systems require accurate frequency control, but the provision for future frequency control protects the buyer against obsolescence.

The military users of SSB are reluctant to make use of automatic frequency control because such systems are subject to jamming. A relatively weak, continuous wave jamming station can capture the receiver control circuits and destroy reception. No comparable condition exists in the suppressed carrier, single sideband system; thus, it is much more desirable for military applications.

*

The United States Air Force has installed a number of ground stations for working with the air fleet equipped with SSB transceivers. Excellent results have been obtained with operational aircraft throughout the world. Effective voice communication is possible between the aircraft and a ground station using SSB, notwithstanding the signal absorption of auroral radio paths when the plane is in northern latitudes.

The AN/ARC-58 *(Figure 3)* provides 250 watts amplitude modulation and 1,000 watts single sideband in transmission. Provision is included for the reception of amplitude modulation and either upper or lower sideband in the SSB mode. Accurate frequency control is available on each of 28,000 frequency channels spaced one kilocycle apart throughout the range 2.0 to 30.0 Mc/s.

The Pilot's Control *(Figure 4)* shows the ease with which frequency can be selected on a digital counter dial. The desired type of emission is also readily selected by the pilot. After selection of emission and frequency, the transceiver automatically tunes under servo control to assure proper resonance of all circuits, to provide full power output at high efficiency. The receiving and transmitting functions are provided in the two main boxes at a total weight of 96 pounds. The 618T-1 *(Figure 5)* provides many of the same features except that its output is 400 watt SSB and 100 watt AM at a weight of only 42 pounds. From the above brief characteristics, it is clear that an AM transceiver, having 28,000 channels and good frequency control, would require about the same number of tubes and transistors.

*

In summary, the use of single sideband will provide;

1. More frequency channels.
2. More power.
3. More effective communications. The 1,000 watt SSB transceiver will be as effective as an 8,000 watt AM transmitter under fading conditions.
4. Lower antenna voltage for a given power rating.
5. Compatibility. A 250 watt AM signal can be provided by a 1,000 watt SSB transmitter. Data systems and teletypewriter signals can be fed in and taken out at voice frequency.

Theoretical advantages of SSB are brought into focus when a passenger in an aircraft over the Mediterranean can telephone his office in the United States through a single sideband station. Such reliability of radio communication was seldom possible with past radio links. It is becoming commonplace with airborne SSB. ←←

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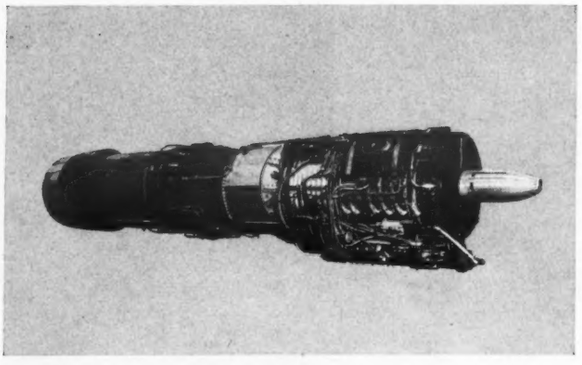
Sea forces will soon be strengthened by the McDonnell F4H and the North American A3J — the fastest, highest-flying aircraft in Navy history.

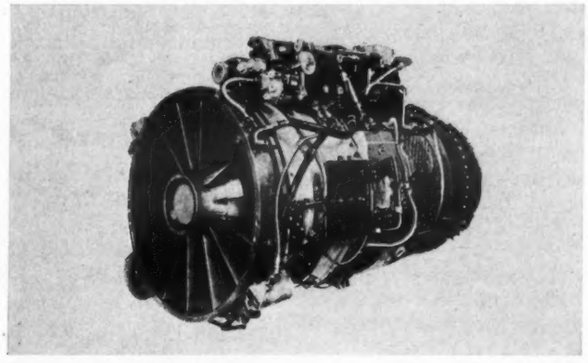
USAF's fastest, highest-flying bomber, Convair's B-58, is J79-powered. And, USAF's J79-powered Lockheed F-104 has held simultaneously the world's speed, altitude, and time-to-climb records — an unprecedented triple crown.

At the other end of the flight propulsion spectrum, G-E small gas turbines will soon enter operational service with the Air Force and Navy. The Navy's newest ASW and utility helicopters will be powered by the T58, which has demonstrated its reliability in thousands of demanding test hours.

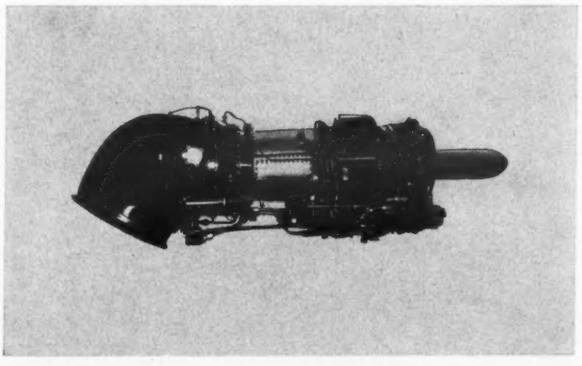
The high performance J85 turbojet will soon enter USAF service powering McDonnell's GAM-72 decoy missile and Northrop's T-38 jet trainer.

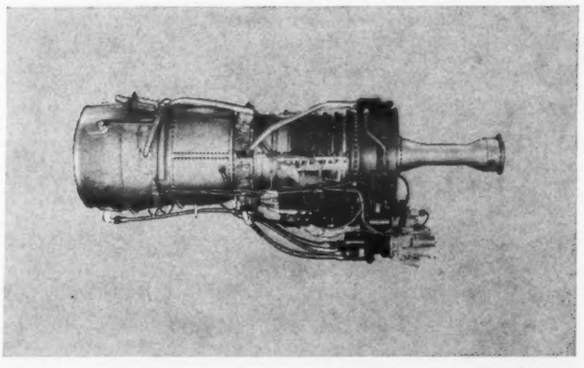


J79 After more than three years of production, General Electric's J79 remains the most advanced U.S. production turbojet. The record-breaking J79 provides more than 15,000 pounds of thrust, yet some models weigh as little as 3,200 pounds. J79-powered aircraft have logged considerably more than half of the world's Mach 2 time. Six of today's Mach 2 air weapons are J79-powered: the McDonnell F4H Phantom II, North American A3J Vigilante, Convair B-58 Hustler, Lockheed F-104 Starfighter (pictured in main illustration), Grumman F11F-1F Super Tiger, and Chance Vought Regulus II missile.



J85 Advanced aerodynamic and mechanical design make General Electric's J85 turbojet the highest thrust-to-weight ratio powerplant in its class. Weighing just 525 pounds and delivering 3850 pounds thrust, the reheat J85-5 powers Northrop's T-38 Talon supersonic trainer (pictured in main illustration) and N-156F Freedom Fighter (right). Another J85 version (above), which weighs 325 pounds and produces 2450 pounds thrust, is in production for the McDonnell GAM-72 decoy missile (right).





T58 The T58 brings important benefits to helicopters—increased payloads or range, faster cruising speeds, greater endurance. Engines shipped have averaged significantly better than guarantees of 1050 shp, 0.64 SFC, and 271-pound weight. A 1250 shp growth version enters production this year. T58 has been flight tested in single and twin engine helicopters including Sikorsky's HSS-1F, HSS-2 (left), and S-62; Kaman's HU2K (left); and Vertol's YHC-1A and H-21D.

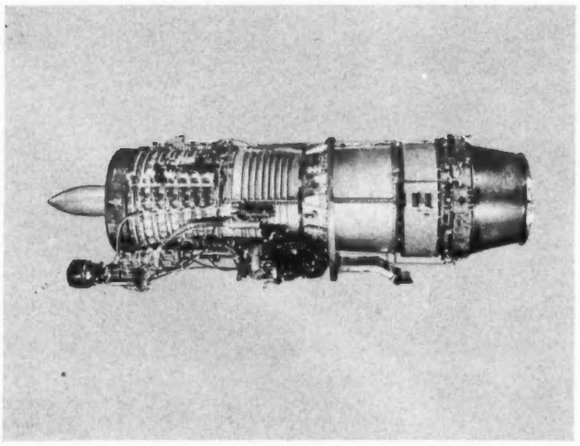
T64 Low SFC and attractive power-to-weight ratio make G.E.'s versatile T64 turboprop/turboshaft ideally suited for a variety of aircraft. Among them: helicopters and fixed wing designs (right) skycranes, new VTOL/STOL designs. Turboprop configurations, with gearbox above or below centerline, deliver 2570 eshp at .522 ESFC. Turboshaft versions produce 2650 shp at .506 SFC. All models have common power sections, differ only in gearing and accessories.

GENERAL ELECTRIC

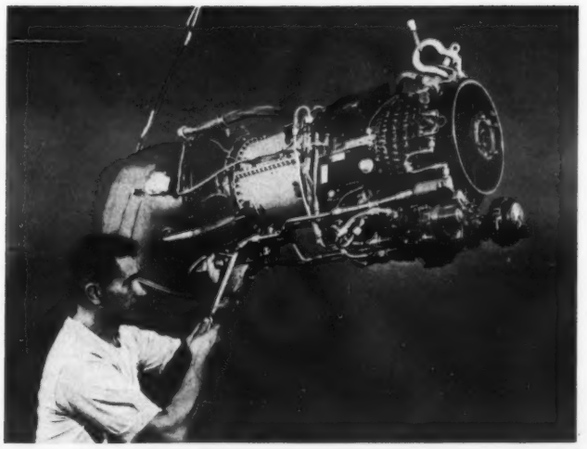
27 million jet flight hours mean

Thoroughly Proven Powerplants

for commercial aviation



CJ-805-3 G. E.'s first commercial engine, the CJ-805-3, enters airline service this spring. It will provide the power to carry passengers in Convair 880 jetliners at 615 miles per hour. The CJ-805 weighs 2800 pounds, delivers more than 11,000 pounds of thrust.



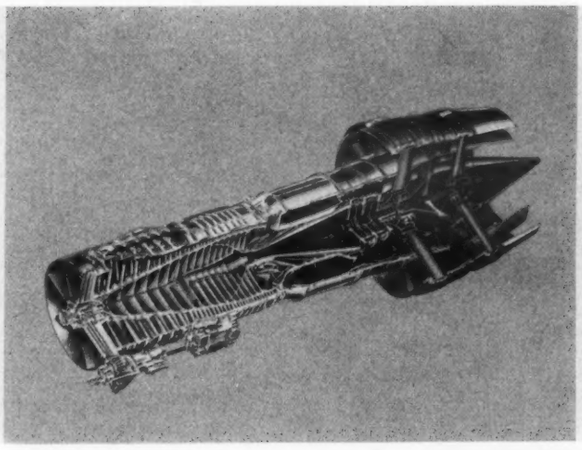
CT58 The CT58 is the first U.S. turboshaft to be FAA-certificated. It will power the twin-turbine Sikorsky S-61 and Vertol 107 (both above) which begin passenger service next year. Sikorsky's CT58-powered single-engine S-62 is being offered to helicopter operators and corporations.

GENERAL ELECTRIC

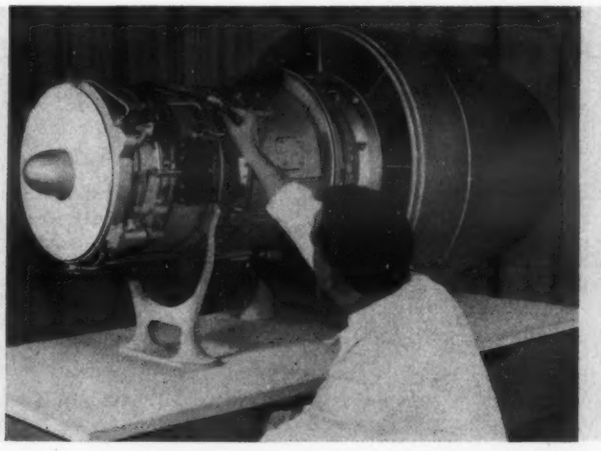
G-E engines will be the most thoroughly tested yet to enter airline service. For example, General Electric's CJ-805-3 flight test program was the first of its kind ever undertaken by a U. S. manufacturer at his own expense to test a commercial turbojet under flight conditions. The CJ-805 powered Convair 880 (above) has exceeded all of its performance guarantees and performed reliably in flight test. Delta Air Lines' first Convair 880 established speed records on its maiden U. S. coast-to-coast flight.

Jetliners powered by CJ-805 turbojet or aft-fan engines have been ordered by American Airlines, Avensa (Venezuela), Capital Airlines, Civil Air Transport (Formosa), Delta Air Lines, REAL (Brazil), Scandinavian Airlines System, Swissair, and Trans World Airlines.

At the other end of the power spectrum: America's first turbine-powered commercial helicopters, already on order by all three of the nation's major helicopter airlines, will be powered by G-E CT58 engines. Next natural step: turbinization of helicopters and transports owned and operated by industry.



CJ-805-23 General Electric is flight testing its leased B-66 with aft-fan CJ-805-23 engines. When tests began, it marked the first time an engine manufacturer had test flown a turbofan engine as the primary powerplant of an aircraft. The twin aft-fan engines are performing reliably—proving themselves prior to airline service. CJ-805-23 engines will power the Caravelle VII and Convair 600.



CF700 Compared to turbojets in its class, the CF700 turbofan will provide higher thrust per dollar, greater range, shorter take-off, and less noise. The CF700 will combine the proven J85 gas generator and a scaled-down version of the CJ-805-23 aft-fan to produce 4,000 pound sea level thrust at 0.69 SFC. Flight worthy CF700s are scheduled for April, 1961, with FAA-certificated engines available in February, 1962.

27 million jet flight hours mean

Greater Capability

for tomorrow's aerospace missions

Twenty-seven million jet flight hours form a solid foundation upon which General Electric research and development can build to meet the needs of the near and distant future.

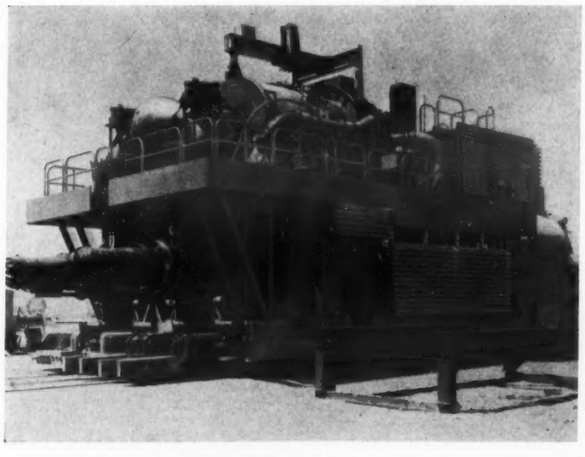
The Mach 3 North American B-70 Valkyrie bomber, for example, represents the next stride forward for manned aircraft. G.E. is developing the highly advanced J93 engines which will power it.

General Electric, under contract with USAF and the AEC, is developing a nuclear propulsion system for America's first nuclear-powered aircraft, as revolutionary as the B-70.

In rocket, VTOL, and space power and propulsion, systems now being investigated at General Electric will help make propulsion progress.

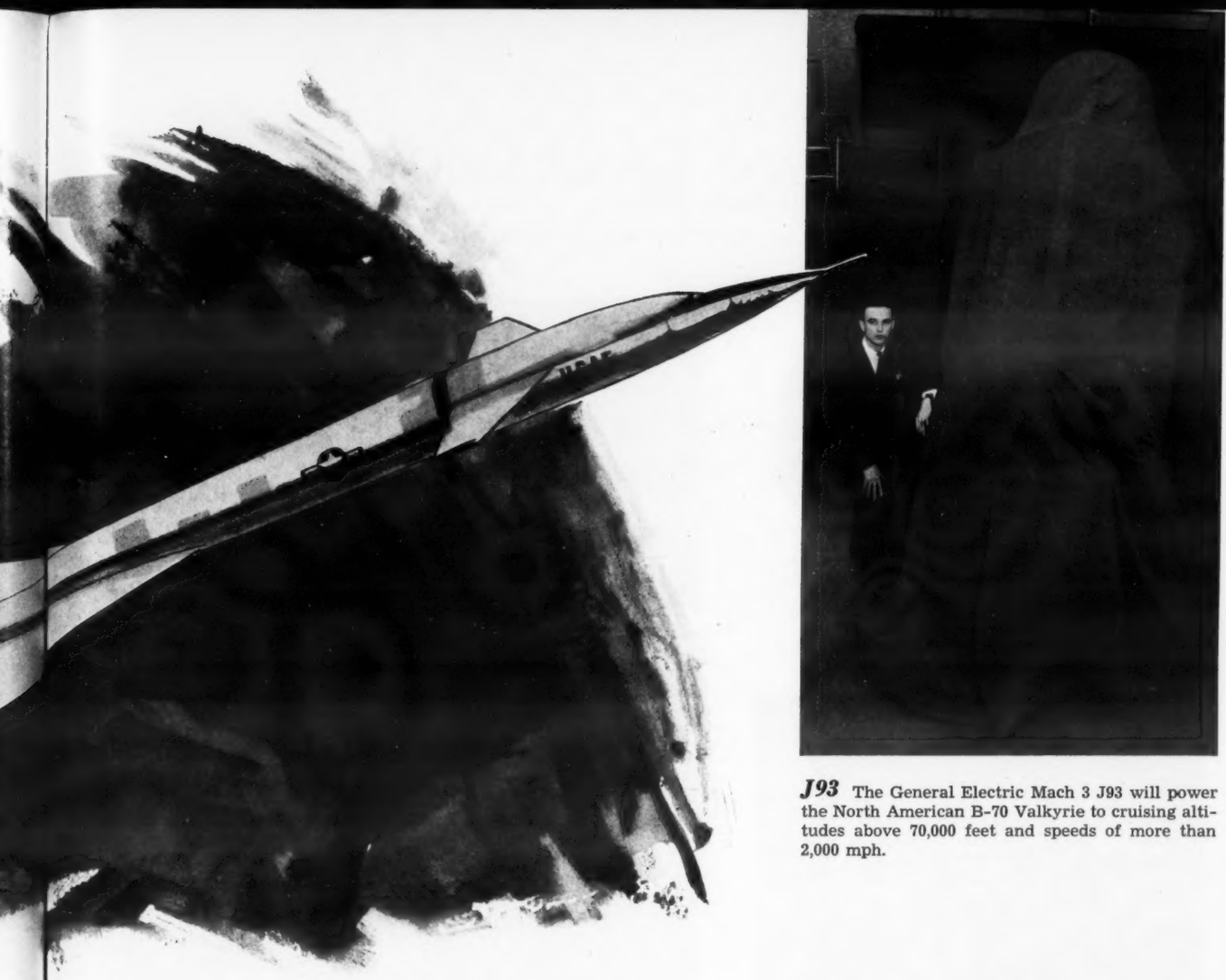
To achieve the challenging objectives of the present and the future, G.E. applies its knowledge and experience, and marshals R&D facilities among the most complete in the nation.

G.E.'s more than 100 research laboratories strive for new basic knowledge which can be applied to aerospace progress. For example, at the pioneering General Electric Research Laboratory, basic research is leading to advances in metallurgy, cryogenics, and other sciences vital to aerospace progress. These activities supplement the direct efforts of extensive aircraft gas turbine R&D facilities at Evendale, Ohio, and Lynn, Mass.

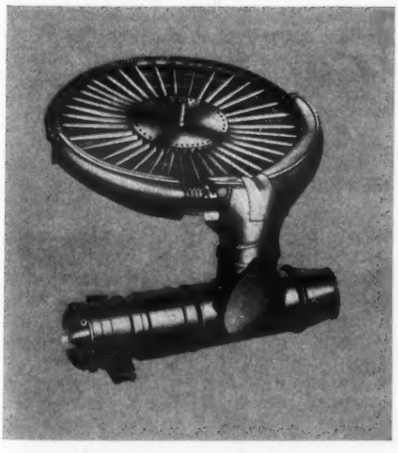


NUCLEAR PROPULSION

This special test assembly was designed and built by G.E. under contract. It consists of a nuclear reactor, shield, controls, and two modified J47 engines. G.E. first successfully operated a turbojet on nuclear power in 1956. Development progress is continuing.

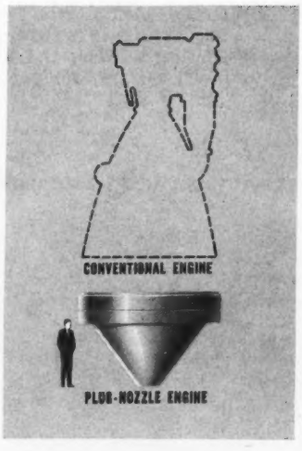


J93 The General Electric Mach 3 J93 will power the North American B-70 Valkyrie to cruising altitudes above 70,000 feet and speeds of more than 2,000 mph.



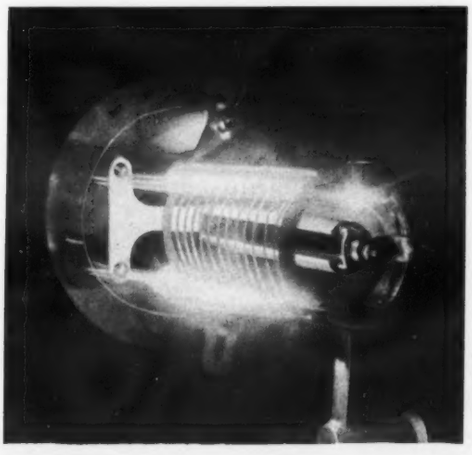
TOMORROW'S VTOL

Currently under development, G-E lift fan engines hold promise for aircraft which can take off straight up, hover, and move forward at high speeds.



ROCKET POWER

Concepts under development at General Electric include the plug nozzle rocket engine. Plug nozzle engines (below) are markedly smaller than conventional engines of the same thrust, and offer operating advantages.



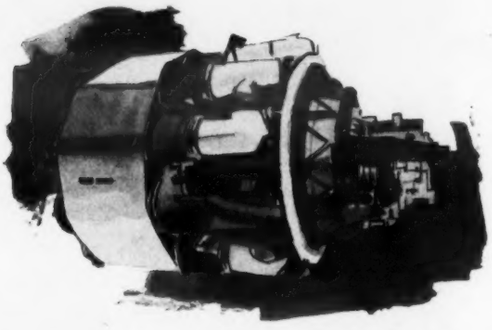
ION ENGINES

In the void of space, a few ounces of thrust can control vehicle flight paths. One way to achieve this thrust: electrical propulsion. G. E. is investigating an ion engine which electrostatically accelerates mass, such as cesium ions, to produce thrust.

GENERAL ELECTRIC

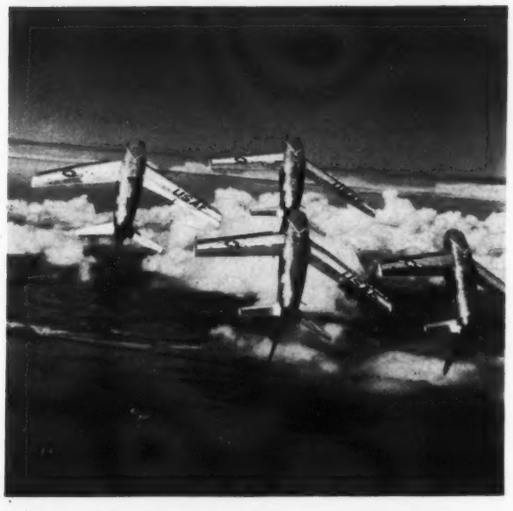
Milestones

in General Electric's 27 million jet flight hours



In 1942, the first jet flight in America was General Electric powered. Twin I-A engines (above) powered the Bell P-59 at 450-mph.

The J47 powers Boeing B-47 Stratojet bombers, backbone of America's deterrent strength during the past decade.



North American's F-86 Sabre Jets, powered by General Electric J47's, scored a 14-1 victory ratio in Korea.

America's first Mach 2 engine, the J79, won accolades for performance and reliability. Vice President Nixon (center) presented the Collier Trophy to (left to right) USAF pilots Major Walter Irwin and Lt. Col. Howard Johnson, G.E.'s Gerhard Newmann and Neil Burgess, Lockheed's Clarence Johnson for F-104/J79 design and flight. (186-38)

GENERAL ELECTRIC ENGINES POWERING THESE AIRCRAFT HAVE FLOWN MORE THAN 27 MILLION JET FLIGHT HOURS:

BELL XP-59A
BELL XP-83
BOEING B-47
BOEING KB-50
CHANCE VOUGHT REGULUS II
CHASE XC-123A
CONVAIR B-36
CONVAIR B-58
CONVAIR 880
CONVAIR XB-46
CONVAIR XP-81
DOUGLAS RB-66A
DOUGLAS XA-26F
DOUGLAS XB-43A
DOUGLAS XB-53
DOUGLAS XF4D
DOUGLAS D-558
GRUMMAN F11F-1F
KAMAN HU2K
LOCKHEED P-80
LOCKHEED F-104
MARTIN XB-48
MARTIN XB-51
McDONNELL F4H-1
McDONNELL GAM-72
NORTH AMERICAN B-45
NORTH AMERICAN F-86
NORTH AMERICAN F-86D
NORTH AMERICAN F-86H
NORTH AMERICAN XFJ-1
NORTH AMERICAN FJ-2
NORTH AMERICAN A3J-1
NORTH AMERICAN XT-39
NORTHROP N-156F
NORTHROP T-38
NORTHROP XF-89
NORTHROP YB-49
REPUBLIC XP-84
REPUBLIC XF-84J
REPUBLIC XF-91
RYAN FR-1
RYAN XF2R-1
SIKORSKY HSS-1F
SIKORSKY HSS-2
SIKORSKY S-62
VERTOL H-21D
VERTOL YHC-1A

Progress Is Our Most Important Product

GENERAL ELECTRIC

FLIGHT PROPULSION DIVISION

CINCINNATI, OHIO, AND LYNN, MASSACHUSETTS

A Good Servant to Air Transport

Société Internationale de Télécommunications Aéronautiques

By General L. M. Chassin, Paris

The aircraft, the "ultimate in transport vehicles," would be incapable of filling its leading role in modern civilization if it were deprived of its nerve system of telecommunications. Without telecommunications, the airlines would be unable to meet requirements for safety, speed and economy. Seat reservations, full and accurate information on loading and unloading operations, refuelling, repairs, financial and commercial operations, customs and taxation procedures, all mean that nowadays every flight must be prepared by a flood of messages which must be as exact and speedy as possible, so as to avoid waste of time and money. The latter would inevitably kill air transport, despite its undisputable advantages.

As the airlines grew, they thus found themselves confronted by many difficult problems. The following article describes how these have been solved by an international organization which is a good example of what the future can be if men listen to the voice of wisdom.

Before SITA

As far back as the early twenties the control of air traffic was taken over by governments, who established special organizations for the purpose. This was both logical and inevitable: in all countries there is an ever-growing belief that all services concerned with the protection of the citizen should be publicly run. But while governments made themselves responsible for the traffic control services, including weather messages and navigation messages, they took no interest in operating and traffic messages, the number of which very quickly grew. The airlines' first idea was either to use ordinary Post Office channels or to ask the official telecommunications services to transmit technical messages as and when their lines were free. This system obviously could not remain in force for long. As soon as aircraft speeds and numbers increased, it led to such delays and waste of time and money that some other method had to be sought.

The big companies then decided to form their own communications networks. They leased circuits, installed communications centres at their principal points of call and bought teleprinters which they operated themselves. But soon they realized that they had gone too far and that the productivity of the new service was very low, since the capacity offered was far in excess of requirements. What is more, such a method was beyond the reach of the more modest companies. This situation led to the idea of cooperation, and to the foundation of Société Internationale de Télécommunications Aéronautiques to pool resources, coordinate their utilization and eliminate those which proved unnecessary.

The birth of SITA

SITA was founded on February 23rd, 1949 as a non-profit-making company under Belgian law. Its head offices were at Brussels. Its object was the study, creation, utilization and operation of telecommunication resources in all countries, with a view to ensuring the transmission of all categories of message of utility to the operation of its member airlines, with the exception of messages of a personal or private nature. The founding companies numbered eleven, including Sabena, KLM, Air France, TWA, Swissair, BEA, BOAC and the Scandinavian companies. Initial capital was 190,000 Belgian francs and was divided into quotas. To ensure that no one company or financial group could acquire undue influence, Article 12 of the articles of association specified that companies of any one nationality or belonging to any one financial group might not hold more than 20 percent of the capital, individual shares being determined each year (Article 10) in proportion to participation in SITA's total expenditure. At the 1959 Meeting, this rule was applied to the French companies—Air France, TAI, Air Algérie, Aérotechnique and UAT—who were limited to the said 20 percent. This clause enables SITA to provide equal service to all its members, regardless of their size. The company has thus very rapidly expanded; the eleven members of 1949 have grown into 80 today, including Aeroflot, and the network covers the whole world.

The company is administered by a Board of Directors with eleven members and an executive committee of five members. But the king-pin responsible for actual operation of the organization is the General Manager, G. A. Monniot, whose office is in Rue Théodore de Banville, Paris.

The development of SITA

The idea of the founding members at the outset was that SITA should limit itself to a coordinating role. It was merely to provide exchange services for communications between member airlines. It did not have any controlling function. But as time went on it became obvious that, if more serious economies were to be attained, SITA would have to become a genuine operator, with its own personnel and equipment. Little by little, it acquired and controlled its own resources. Today it operates 75 transmission centres in 35 countries, with a total employee strength of just under 800. The number of messages handled rose from less than one million a year in 1950 to more than 17 million in 1958. This spectacular figure has obliged the company to go in resolutely for automation, which alone will enable it to meet the constantly increasing demands made upon it as world air transport grows.

The technical system

The transmission system is based on the use of teleprinters (or radio teleprinters for overseas communications), and the keyed radio transmissions of the early days have been gradually eliminated.

In 1951 SITA had a total of 25 circuits (12 wire circuits and 13 radio circuits, including 2 radio teleprinters). Today, the number of circuits has reached 113 (13 radio teleprinters and 100 teleprinters). The radio teleprinters operate to Athens in Europe (the only point in the old continent); Brazzaville, Casablanca, Dakar, Cairo, Tunis and Antananarivo in Africa; Beirut, Teheran and Tel Aviv in the Middle East; and New York, Rio de Janeiro and Fort-de-France in the New World. In 1958 SITA's network transmitted some 380,000 million words, an increase of more than 13 percent over 1957.

Whenever possible, SITA uses telegraph lines, on circuits rented from the Post Office authorities of the countries served.

Up until last year the company was still using the radio station which it inherited from Air France (call sign TZP). But, as the latest report states, "great progress has been made in the number of rented circuits, and we now have no difficulty in obtaining them. Hence, despite certain regrets, we decided to close TZP on January 1st, 1959."

Thus the sole method now in force is telegraphy, using transmission centres. The centres at London, Amsterdam and Paris have recently been converted to semi-automatic operation, pending the introduction of a fully automatic transmission system.

The Paris exchange, which can be quoted as an example, is located at 184 rue du Faubourg St-Denis, in the heart of the French capital. It employs a total of 186 persons and can transmit up to 12,000 messages per hour.

The problem of the constantly increasing number of messages to be transmitted was not an easy one to solve. One method might have been to increase the number of automatic transmitters controlled by each operator. But this solution could not be considered seriously, since—apart from its cost—a single operator could not handle more machines without moving from one desk to another, or in other words creating the very confusion which it was desired to avoid. Before conversion to semi-automatic operation, it was common to see operators depositing messages in front of transmitters which could not cope with them because there were no lines free. This led to confusion, delays and sometimes loss of messages. Finally, the suggestion was made to use electronic memories to store messages and pass them on automatically to the transmitters.

The Paris exchange passes messages on 80 outgoing channels. The operators (most of them women) cut off the punched tapes received from the punching machines on the incoming channels and place the torn tape in the automatic transmitters, which pass them on, without delay, as soon as there is a line free in the required direction. Until this time, the messages are stored in an electronic brain. Messages to multiple

Inside SITA's semi-automatic communications centre, rue du Faubourg Saint-Denis, Paris.

Part of the electronic store in the Paris communications centre.

A woman operator at her desk.

destinations can be sent without difficulty from any operator's post. All this uses a central storage unit capable of recording both messages for retransmission and the destinations to which they are to be sent. How this unit works will be described later.

Finally, the operator's work has been greatly simplified and is carried out in a very orderly manner. Work desks are arranged in several rows. Each has a keyboard with 80 keys corresponding to the outgoing lines and, underneath, the automatic transmitters (generally four in number). Alongside the operator are the teleprinter receivers, which churn out punched tape almost continuously.

As the tape unwinds, the operator notes its point (or points) of destination, then places the message in one of her transmitters and presses the key corresponding to the destination (or destinations). Having done this and quickly checked that the correct lamps have lit up, all she now has to do is push a button. The automatic machine then takes over. The whole operation has taken less than a minute.

The central storage unit consists in essentials of four matrices, two of which (1 and 4) are identical. In each matrix the number of horizontal rows of ferrite cores is equal to the total number of telegraphic stores used in the station. In matrices 1 and 4, the number of vertical rows equals the number of outgoing lines. Matrix 2 takes charge of message priorities. In the Paris centre there are two degrees of priority, hence two vertical rows. Finally, matrix 3 files messages in chronological order.

As soon as an outgoing line becomes free, the central memory is automatically scanned, and the appropriate message passed to the free line, with due regard for degree of priority and length of storage. This operation takes just *46 milliseconds*. The system functions extremely well and without breakdowns.

Equipment is installed in telephone-type cabinets, protected from dust by glass doors. The electronic circuits in the central storage unit are designed along the most modern lines and installed in narrow racks which can easily be withdrawn by hand for inspection or replacement. For its capacity of 12,000 messages an hour, the full installation has 25 miles of cables and more than 150,000 soldered connections. Current is supplied by the normal grid, with an emergency generator to function immediately should the grid supply fail.

The future

SITA's future looks bright, both from the commercial and financial and from the technical points of view. During 1955 the company accepted new responsibilities in the Far East, under Article 3 of its charter. Article 3 stipulates that the company "will also provide, at the request of governments or international organizations, air-ground communications and radio navigation aid services, provided agreement is reached on the financial conditions of such services. It may similarly undertake tasks in the technical field of communications."

Thus SITA operates a number of air-ground services in South Viet-Nam, Laos and Cambodia, for the airlines operating to these countries. It has also installed a number of radio aids in these territories, at the request of the local civil aviation authorities. And in Iran, SITA operates the official network of fixed telecommunications on behalf of the Government.

During 1958 new centres were opened in Brazil and Argentina, as well as in Manila, Copenhagen, Helsinki, Stockholm, Istanbul and Prague. In his report to the 1959 Annual General Meeting, Chairman R. Bougge, of SAS, revealed that negotiations were in progress for new activities in Poland, the USSR, Yugoslavia, Tunisia, Hong Kong, Tokyo and America. He was particularly happy to report on the support of the Comité Consultatif International du Télégraphe et du Téléphone (International Telegraph and Telephone Consultative Committee) in dealing with SITA's problems and requests. Finally, he drew members' attention to the help given by national Post Offices. "Let us not forget," he said, "that a bare ten years ago, when SITA was founded, sharing of circuits was not authorized, even in Europe. Since that time our company has gradually achieved recognition as a user almost everywhere, thanks chiefly to the fact that it is recognized as working in the service of air transport as a whole without national or international discrimination. This year again we have made progress in Greece and in the Lebanon, while London has recognized us as users on all the non-European circuits . . . International cooperation is the cornerstone of a system like ours. It is not always easy to achieve. Those who play the leading roles must always understand and appreciate the problems of all participants and be capable of creating a spirit of moderation and sympathetic comprehension which will enable us to set up rules acceptable to all."

In the technical domain, considerable improvements can be forecast for the next few years. The recently created Planning Section is in touch with the firms of Siemens and Philips and hopes, with their aid, to solve the problems of automatic reservation and fully automatic message transmission within the next few months. At the same time another committee, under R. Bougge, is making an exhaustive examination of airline needs in the matter of communications. It has already published a highly interesting report.

Conclusions

SITA is not the only company in the world which provides telecommunications for the airlines. For example, there is International Aeradio Ltd. in London, which was founded in 1947 and handles not only traffic messages but also safety messages. Although several European companies participate in IAL, the management and the majority of the shares are British. There is also Aeronautical Radio Inc. (ARINC), a purely American company whose main purpose is to organize and operate telecommunications services at points of call and which has some fifty members, including several European airlines. But the most original feature of this company is its advisory and design study service which enables it to improve the methods and even the equipment utilized in aircraft.

It is certainly regrettable that only one of these three companies—namely SITA—is truly international. As a British journalist wrote in 1949, national companies inevitably act as representatives of their own national industries and consequently prevent the standardization of equipment on international air routes. A radical solution proposed by the same writer was to merge IAL, ARINC and SITA and place the resulting organization at the disposition of IATA. But this suggestion, though made more than eleven years ago, has never been followed up. ←←

List of SITA Members
as at November 1st, 1959

Air Ceylon (Ceylon)
Air France (France)
Guest Aerovias Mexico S.A. (Mexico)
Air Algérie (Algeria)
Air India International (India)
Air Jordan (Jordan)
Aviación y Comercio S.A. (Spain)
Aerolineas Argentinas (Argentina)
Royal Air Maroc (Morocco)
Finnair (Finland)
Alitalia (Italy)
British Overseas Airways Corp. (United Kingdom)
British European Airways (United Kingdom)
Canadian Pacific Airlines (Canada)
Cambrian Airways Ltd. (United Kingdom)
Compañia Cubana de Aviación S.A. (Cuba)
*Cyprus Airways Limited (Cyprus)
East African Airways (Kenya)
Aer Lingus (Ireland)
Qantas Empire Airways (Australia)
Ethiopian Air Lines Inc. (Ethiopia)
Ariana Afghan Airlines (Afghanistan)
Ghana Airways (Ghana)
Gibraltar Airways (Gibraltar)
Iberia Lineas Aereas de España S.A. (Spain)
Aerlinte Eireann Teoranta (Ireland)
Iranian Airways Corp. (Iran)
*Air Inter (France)
Jugoslovenski Aerotransport (Yugoslavia)
Kuwait Airways (Kuwait)
KLM Royal Dutch Airlines (Holland)
Lebanese International Airways (Lebanon)
Deutsche Lufthansa (Germany)
Air Laos (Laos)
Air Liban (Lebanon)
Polskie Linie Lotnicze (Poland)
Linea Aeropostal Venezolana (Venezuela)
EL AL Israel Airlines (Israel)
Middle East Airlines Company (Lebanon)
Misrair (Egypt)
Trans Mediterranean Airways (Lebanon)
Olympic Airways (Greece)
Ceskoslovenske Aerolinie (Czechoslovakia)
Austrian Airlines (Austria)
Overseas National Airways (USA)
Panair do Brasil S.A. (Brazil)
Pakistan International Airlines Corp. (Pakistan)
*Philippine Airlines (Philippines)
Persian Air Services (Iran)
Royal Air Cambodge (Cambodia)
Varig (Brazil)
*Real S.A. Aerovias Transportes Aereos (Brazil)
South African Airways (Union of South Africa)
Seaboard and Western Airlines (USA)
*Cruzeiro do Sul (Brazil)
Scandinavian Airlines System (Sweden)
Sabena (Belgium)
Swissair (Switzerland)
Aeroflot (USSR)
Syrian Airways (Syria)
*Sithon Akat (Laos)
Trans Canada Airlines (Canada)
Tasman Empire Airways (New Zealand)
Thai Airways Company (Thailand)
Transports Aériens Intercontinentaux (France)
Turk Hava Yollari (Turkey)
Transocean Airlines (USA)
Transportes Aereos Portugueses (Portugal)
Tunis Air (Tunisia)
Trans World Airlines Inc. (USA)
Union Aéromaritime de Transport (France)
Aigle Azur Extrême Orient (France)
Aéro Technique (Algeria)
Air Vietnam (Vietnam)
West African Airways Corp. (Nigeria) (Nigeria)
*Flying Tiger Line Inc. (USA)

*Observers

Electronics

Air Traffic Control in Soviet Civil Aviation

By Y. Verezotsky, Department Head, Aeroflot, Moscow

A crew being briefed at Moscow–Vnukovo. Aeroflot crews and Air Traffic Control personnel are subordinate to the same authority.

Aeroflot has chosen positive means of controlling the traffic on its airways. Pilots receive continuous directions from the Air Traffic Control Service from the moment the aircraft leaves the hangar until it is parked on the apron. Not a single movement can be made without authorization or supervision.

It is obvious that uninterrupted communications must be maintained with the aircraft from the ground. This purpose is served on the one hand by *control lines*, on the other by *communication lines* consisting of receivers, data evaluating systems and computers, with installations for passing information and instructions to the aircraft.

The USSR, like other countries, also knew a time when radio transmitters and direction-finding stations were adequate for the guidance of air traffic. Today, however, Air Traffic Control services need far better equipment for air route surveillance, communications, navigation and landing. All these aids must, of course, be swift and reliable in operation. Thanks to the planned development which is an integral factor of the Soviet economy, it was possible to equip air routes in the Soviet Union faster than in other countries.

All Aeroflot's commercial routes are divided into zones for receiving the signals of non-directional beacons (NDBs), and all turns in air routes are marked by radio beacons. This helps the pilot to maintain his prescribed flight path with the aid of his radio compass and report to the appropriate air traffic controller as he passes over each check point. All commercial routes are in addition provided with position-finding zones. Direction-finding stations tell the pilot the position of his aircraft at any given time, whether his radio is tuned to HF, VHF or UHF.

All the above systems act purely as aids in special cases. They are, in a sense, relics of an age when the USSR had nothing but piston-engine aircraft.

Today, however, radar has become by far the most important source of information for air traffic control. Although on international routes it is common for pilots to report as they pass over check points, this procedure is of secondary importance in the USSR. Radar data are of considerably greater value to the air traffic controller than air-to-ground position reports, as a radar can detect aircraft which are not in radio communication with the control station.

Aeroflot has surveillance and weather radars on all its main routes. In addition, precision approach radars are available, which enable the radar operator under the command of each air traffic controller to ensure that aircraft coming in to land maintain the correct course and glide path, giving them all the necessary instructions for a safe landing.

Aeroflot almost certainly leads the world as regards the number of air routes and airports equipped with radar, radio beacons and direction-finders.

*

It is characteristic of Aeroflot that aircraft crews and air traffic control personnel are all subordinate to the same authority. This enables the Air Traffic Control service to exert an active influence on traffic. Wherever an aircraft may be at any time, its pilot is never left to his own devices, but can always rely on the expert aid of a controller. What is more, our Air Traffic Control services and communications are constantly undergoing improvement.

In the case of radio communications we normally use voice radio, except where language difficulties or atmospheric conditions (such as storms) make the use of telegraphy preferable. In determining the

The control room at Moscow–Vnukovo. Next to control officer Alexei Tsarkov is interpreter Vera Kurdyumova, who helps when foreign aircraft are talked down.

Model of a Soviet-designed mobile airport radar consisting of a surveillance unit (left) and a precision approach unit.

composition of air crews we naturally take account of Radio Communications Service requirements, and, if necessary, a radio officer makes the trip with the crew.

The problem of air-ground communications frequently arises owing to the enormous distances between airports in the Soviet Union. For this reason a large number of relay transmitters have been set up, which play a vital role in areas beyond the range of airport transmitters. Thanks to a careful selection of installation sites for auxiliary transmitters, ground-air radio communications can today be maintained without interruption.

For dealing with *short-distance* traffic all airports use VHF communications, supplemented by HF for reliability. In this way all aircraft are constantly in touch with ground stations. The development of *long-range communications* has also, however, been highly gratifying, for they have greatly assisted rapid jet services on Aeroflot's entire network, both domestic and foreign. On various flights made to the United States, Soviet turbine-powered aircraft were still in touch with the Moscow Air Traffic Control Service as they taxied over the runway at New York International Airport. All conversations between crews and controllers are recorded on magnetic tape, and the movements of the aircraft before and after landing are photographed.

Modern aviation demands that all equipment working in conjunction with ground stations operate swiftly and reliably. Aeroflot is the only airline in the world which owns not only its aircraft, but also all the airports and radio equipment. Under these circumstances it is understandable that ground services can devote much attention to the interests of flight personnel.

On the air routes of the Soviet Union an aircraft's position is normally determined from at least three sources: once by radio beacon, and again by two different radar procedures. Never at any time is any one of these methods used on its own. If, for example, the direction-finder is not operational, the two radar procedures are used.

Power supplies for the radio equipment are provided in duplicate, and stand-by units are ready for rapid insertion in the event of a breakdown. A constant watch is kept to ensure maximum reliability.

Our instrument landing procedure is worthy of special mention. At airports certificated for jet aircraft the so-called "triple landing control system" is in operation. One of its basic components is the SP-50 system which, like the American ILS, uses a landing course and glide path transmitter. Whereas, however, the ILS marks the control path by means of an amplitude modulation of 90 and 150 c/s, the SP-50 works by *phase modulation*. In addition, it possesses automatic devices for zone stabilization, and special antennas. Two marker beacons are set up at fixed points along the approach path. When landing in bad weather the pilot is considerably helped by two further beacons each side of the runway. These ensure a safe landing with a horizontal visibility of as little as 300 yards and a cloud ceiling of 100 ft. The position of the landing aircraft is monitored by two airborne indicators. Here the glide path indication is continuously compared with that furnished by the altimeter, and the distance from the end of the runway is reported as the aircraft flies over the 4-kilometre and 1-kilometre markers.

Finally, this reliable dual system is completed by landing radars which can be moved to cover any direction of approach; their transmitters and receivers are also duplicated.

*

The landing aids used at Aeroflot's airports are as a rule fully automatic and hence require no personnel to control their operation. If there is a perceptible deterioration in the quality of the data, or if an installation breaks down, the automatic monitoring equipment switches over to a replacement transmitter within a few seconds. Power supply, too, is automatic. Finally, since two remote-controlled transmitters are available for each channel, many radio transmitting stations can work without permanent operators. *All these systems, whose operation is as reliable as it is swift, guarantee a high degree of flight safety.* ✦✦

Moscow control centre is responsible for air traffic within a radius of 60 miles. Picture shows zone controller Grigori Samoilenko with his assistant Evdokia Bezrutchko.

Electronics

Spanning Sea and Sands

International Aeradio in Malta and Libya

by D.H. Wood, London

Air traffic control communications are the lifeblood of aviation, and upon their efficiency and improvement depends the success or otherwise of jet age air transport.

Having this well in mind, I was delighted to be invited by International Aeradio Ltd. to see the Malta Flight Information Region and the Libyan air traffic control layout which IAL equips, operates and staffs under contract to the respective national governments.

Over 812,000 square miles of sand and sea make up the area covered by the Malta FIR—a vivid contrast with the closely packed communications areas of Europe and the USA.

It provides a vital transport link between Southern Europe and the African continent and carries heavy traffic in jet bombers, transports and supersonic fighters from British and U.S. bases in the area. In the inhospitable Libyan desert, air transport has also mushroomed as prospection for oil progresses on over 80 concessions.

Accompanied by Eric Warburg, International Aeradio's Commercial Manager, I set out for Malta by BEA *Viscount*. Although nominally fourth on the waiting list for the flight, I had no trouble in finally getting a seat, thanks to the airlines' perennial no-show problem.

Malta, the George Cross island, has had a long and eventful history, not the least part of which took place in the years 1940/43. The hard rock is still scarred with bomb craters, and blast pens which once housed *Hurricanes* and *Spitfires* sprout out from the edges of long disused perimeter tracks.

Malta boasts three airfields, of which Luqa is the most important. Luqa, with its 6,000-ft main runway, is constantly busy. On one side of the field are RAF *Shackleton, Valiant* and *Canberra* squadrons together with numbers of service aircraft in transit. On the other side is the modern and well-appointed civil airport building handling *Viscounts, Britannias, Skymasters* and DC-3s etc.

Beyond the runway intersection lies the control tower, which houses the IAL Flight Information Centre and its associated teleprinter rooms, and

A Bristol *Britannia* over the statue of Romulus and Remus in Tripoli.

Diagram of the IAL aeronautical point-to-point communications network in the Malta F.I.R. In the following list the first two figures are the daytime transmitting and receiving frequencies, and the third figure (where applicable) the night time frequency.

1 13,750/5,275 kc/s
2 5,900/2,682 kc/s
3 9,200/3,887 kc/s
4 9,140/2,736 kc/s
4a 9,140/2,736 kc/s
4b 9,140/2,736 kc/s
5 9,140/2,736 kc/s
5a 9,140/2,736 kc/s
5b 6,957.5/— kc/s
6 19,905/8,140 kc/s
7 17,590/15,662.5/3,887 kc/s
8 9,140/2,736 kc/s
8a 3,680/9,411 kc/s
8b 19,908/12,247/8,140 kc/s
9 6,957.5/— kc/s
10. 5,818.5/2,398.5 kc/s
11 5,818.5/2,398.5 kc/s
11a 5,818.5/2,398.5 kc/s
12 5,818.5/2,398.5 kc/s
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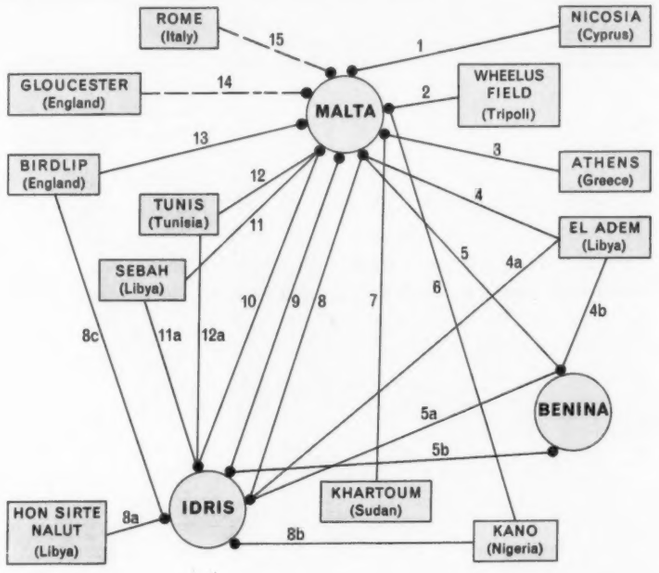
14 not quoted
15 7,815/2,832 kc/s



The W/T section of the Communications Centre, Malta.

The control tower at Idris airport, Tripoli.

The remote controlled HF transmitting station at the Communications Centre showing the transmitters and monitoring console.

The IAL Communications Centre, Tripoli for the oil companies operating in the area. The VHF aerials are for the local telephone network.

I.A.L. Controllers familiarise themselves with the radar equipment at Wheelus Air Base, Libya, prior to commencing duties with the 633d AC&W Squadron, United States Air Force.

this was my first port of call. IAL's Manager in Malta, Eddie Palmer, was unfortunately in hospital after a minor operation, so Ken Porter, Signals Officer, kindly showed me round. The FIC and its associated machinery are housed in a building which is rather cramped, but IAL has every hope of moving into new and more spacious accommodation this year. The current building was in process of repair following the attentions of a *Viscount* which had lost its hydraulics after landing and had careered into the wall. The only laconic comment was "Perhaps the pilot tried to file his flight plan without getting out of the cockpit!"

The civil traffic handled by Malta FIR is mainly U.K.-Rome-Malta, and on to Tripoli, Nigeria and the Belgian Congo. Excellent cooperation exists between the Malta and Rome FIRs, and flights are taken over by Malta at the Sicily coast abeam Catania. The FIR handles both military and civil traffic until, in the case of Luqa, it is handed over to the RAF airfield control.

IAL provides the Flight Information Centre with two controllers on duty simultaneously from 7 a.m. until 12 p.m., and one between 12 p.m. and 7 a.m. The Telecommunications Centre alongside has a staff of 144, while the Aero Information Section, i.e., NOTAMs, has a staff of 24. The Accounts Department has the additional responsibility of collecting charges, landing fees etc. on behalf of the Government.

The division of control is as follows: The "A" position controls aircraft flying within about 200 miles radius of Malta using mainly VHF; the "B" position covers the rest of the FIR on HF. There is continuous coordination between the two positions. The "A" controller provides hand-over information to Rome, Malta Approach, Tunis or Tripoli, while the "B" controller hands over information to Rome, Athens, Khartoum, El Adem and Benina.

In an FIR a staggering number of messages of all types are handled daily. The Communications Centre in an 18-day period sends out over 19,000 signals and receives over 14,000, with a daily average of about 1,200 in and 900 out on eight circuits: Birdlip (U.K.), Tripoli, Benina, El Adem, Khartoum, Kano, Wheelus Field, Nicosia, Greece, Rome RTT and Gloucester RTT (U.K.).

The Air Ministry at Malta provides the meteorological service with full forecasting up to 50,000 ft, the messages being passed via IAL. The daily average of met. message groups received is some 16,000. Aero fixed telecommunications messages are always on the increase, as the Malta figures show: from 765 in 1953 to 1,070 in 1959.

The facilities of an FIR are constantly under review, and new equipment is procured as fast as finance allows. The diagram of IAL's aeronautical point-to-point communications in Malta FIR shows the wide range of radio facilities already installed, including 24 transmitters varying in power output from 0.3 to 2½ kW. This year the Malta FIR will complete a re-equipment programme which will include four Redifon G. 67 2 kW HF/RT and two Mullard SL.25 2 kW HF long-distance transmitters.

For air traffic control, staffing is always a problem. In Malta IAL is able to recruit most of its personnel locally, including the controllers, who are trained and licenced in the U.K. On the telecommunications side youths of 16 are taken in on what is virtually an apprenticeship, working as signals messengers for 2 to 2½ years. If they show aptitude and keenness they are assisted to learn Morse and teleprinter operation at night school and are given spare-time practice at the FIC. After the 2½ years are up suitable pupils become junior operators.

On the operator side there is no shortage of applicants but, as in many countries, technical maintenance workers are a problem. IAL trains radio mechanics, but very often when they are fully qualified they emigrate to other parts of the Commonwealth.

•

Our next stop was Tripoli, only one hour's flying time from Malta, and pleasantly sunny even in winter. The main airport, Idris, like Malta, is jointly occupied by the RAF and civil operators, all the control being done by IAL. Idris was originally the Italian Air Force airfield of Castel Benito, much frequented by General Balbo in the thirties, when it was adorned by Savoias, Capronis and Fiats.

The local BEA Manager, Wally Walton, ever helpful over the usual wad of customs and entry forms, drove us the 16 miles into town, together with Frank Borrodaile, General Manager of IAL Libya, who was to be our host for the rest of the week.

Tripoli is a pleasant town, one side modern Italian architecture and the other the walled Arab quarter. In the office at Villa Albernozzo IAL administers the work of Libyan Air Traffic Control, two VHF/HF radio operations rooms for the oil companies, the Flight Supervisory Service for the desert, VHF and HF networks for such clients as the Bank of Libya, and a radio training school —no mean task in a country which is some 1,000 miles wide and nine-tenths desert.

At Idris IAL controls all traffic, including approach control for aircraft to the giant Wheelus U.S. Air Force Base, to the east of Tripoli. The base itself also employs five IAL controllers for round-the-clock radar watch. Improvements at Idris are the order of the day, with new IAL control consoles due for installation in the control tower in a couple of months.

IAL recruits as much labour as possible locally but, as Libya has been independent only since the war, there is a great shortage of suitable applicants who can be trained in operating and maintenance —a problem which is common to many countries in the Middle and Far East. The IAL school is training a certain number of mechanics, but it will be a long time before there are enough to cover the growing demands of a State which relies heavily on wireless for its direct communications. Nevertheless, IAL employs no less than 210 local staff in Libya.

The company has 43 U.K. contract staff in Libya and 23 air traffic controllers. Thirteen radio

engineers are based at Tripoli, six signals staff, two radio engineer instructors and a resident fire officer at Idris—the airport fire brigade and ambulance being yet another service the company contracts for.

*

The most recent and probably the most impressive undertaking by IAL is the *Oil Companies Communications Network*, which is unique. As concession working in Libya grew over the past two years, it became apparent that day-to-day communications presented a major headache, as did the control and surveillance of aircraft supplying the innumerable oil-drilling rigs and survey parties. The situation was aggravated by the fact that some of the camps are moved many miles in a matter of weeks.

IAL's Engineering Division at Southall drew up plans for a comprehensive system which would keep a group of oil companies' offices in touch with their sites at any time and would supervise the flying side—which is all-important in a desert region where a crashed aircraft may not be discovered for as long as twelve months!

The whole system was combined into the "Oil Companies Radio Network" and housed in a new building south of Tripoli, which has under its roof the Flight Supervisory Service (FSS), an operations room for the oil companies' radio, an equipment room and a workshop.

In the Flight Supervisory System room is an IAL control console with, on the left side, a VHF 3-channel set covering met. signals and the tower at Idris, and on the right a VHF telephone connecting through to the oil companies' radio network in Tripoli. The controller uses HF/RT for aircraft communication under the name "Tripoli Aeradio" with the call sign "Love Peter." In addition, there is a teleprinter link with the IAL town office where the oil companies can obtain ETAs and situation reports on their aircraft.

About 50 aircraft operate into the desert, some run by the oil firms themselves, and others under charter by such companies as Silver City Airways, Worldwide Helicopters, Air Jordan, Aero Contractors and Sabena.

When an aircraft is airborne from Idris outbound into the desert, the tower passes a message to the Flight Supervisory System, a typical one being "G-LF QTN LMLI 0631; QRE FI 66 0750; ASC FL 60 VFR; TNB 16; QBD 0630; QRX QGV"; which, literally translated, means that Golf Love Foxtrot departed Idris 0631 estimating Foxtrot 66 (a concession camp) at 0750, ascending to flight level 60 VFR; total on board 16; endurance 0630 hours; will call when camp in sight.

The information is noted on special sheets at the FSS, and a flight plan is drawn in pencil on a celluloid chart. In any emergency the FSS will know the track and position at the time of the last call, and the rescue sequence can be put into operation. Some aircraft find difficulty in raising Malta on HF, and when they change their flight plans from VFR to IFR the FSS takes the message and relays it to Idris.

Adjoining the FSS is the oil companies' radio network room. Here three special IAL consoles are used to link the desert on 70 circuits with 36 offices or even bedsides in Tripoli. In the concessions IAL has supplied and is maintaining fifty-five 50W mobile HF transceivers and 19 GEC/Plessey 150W drilling rig transceivers, all of which are on hire to the oil firms. A similar but smaller communications centre is run by IAL in Benghazi, and this covers the eastern half of Libya with eight VHF local circuits. Between them Benghazi and Tripoli handle 21 rig stations and 55 mobile stations.

Each out-station has a call-sign, and when the resident engineer or store-keeper wants to pass his routine daily message on the state of work or the larder he merely calls up "Love Peter." The call is received at one of the IAL consoles, and the operator (usually the wife of a British Army man serving in Libya) switches it through on an automatic exchange to the VHF circuit, when a bell is rung at the appropriate office or residence in town.

Every kind of emergency is dealt with via the centre, including many calls for aircraft to pick up men from the rigs who have had falls or have been blown up by the landmines which still litter the desert; lorries get lost, petrol runs low, or lack of dynamite holds up blasting. While I was watching the system in action, a rig, Mike 14, called up to say that the doctor had dropped dead from heart failure and could the police be flown out so that the burial etc. could be put in hand.

Behind the network control room are the banks of Plessey PR receivers, with 100 percent stand-by and a 5-channel preselector for each bay. In the same room is housed a complete teletype facility for the National Bank of Libya and Marconi HF independent side band and Pye VHF communications between the banks in Tripoli and Benghazi.

IAL has a separate transmitting station for the network, with seven Redifon G-40 500W transmitters, six for the oil companies and one for the FSS. Seven GEC BRT. 455 150W transmitters provide the stand-by. Two more BRT.455s provide the Tripoli-Benghazi link and the mobile network for survey parties etc. Power at both receiving and transmitting stations is from a diesel engine with a stand-by in each case.

*

No tour of inspection is complete without seeing the other side, so at an unpleasantly early hour in the morning Eric Warburg and I drove out to Idris to hitch a ride on a Silver City aircraft bound for the desert.

No air hostesses on this trip! The "waiting hall" was a small room in the back of a hangar with a wooden table, an oil stove and a choice collection of pin-ups. Our fellow-passengers consisted of a number of Arab labourers and a handful of American, Dutch and British oil engineers, including the Vice-President of the Burden drilling company, resplendent in a ten-gallon hat.

On board the DC-3 seating was provided on one side of the gangway, while on the other was an enormous stack of tyres, light fittings, oil stoves, tinned milk, tins of apple pie, sacks etc. and a

IAL General Manager, Libya, F. M. C. Borrodaile (standing centre) E. Wright, Airport Controller, Idris Airport (seated) and I. Azzabi, assistant to Mr. Wright (left).

An engineer at the control console in the IAL Communications Centre.

An air operator in the Communications Centre. The *Airlite* headsets are supplied by *Airmed Ltd.*

An air traffic controller working on the Flight Supervisory Service. In the background can be seen the chart on which desert flight plans are marked.

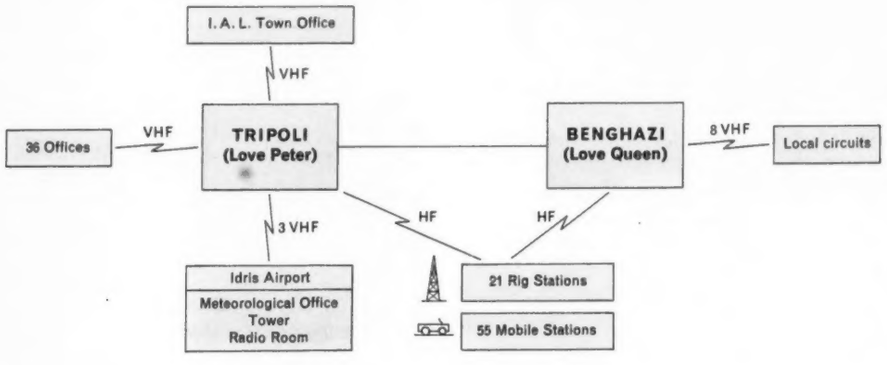
stretcher whose last occupant had been airlifted (thanks to the radio network) following a rather rapid descent from the top of an oil rig.

Once airborne, we passed over the narrow fertile coastal belt, the vegetation thinned and the desert stretched away as far as the eye could see. The desert, although of one colour, constantly changed, with rocky escarpments, dunes and wadis, great beds of long dried-up rivers. The horizon always looked blue in the sunlight, just like an ocean that was not there.

Our first call was at Bir Tlacsin, southwest of Tripoli in Libya Shell NV's concession 70. Here there was a group of air-conditioned caravans, power station and water pump, and five miles distant the pipeline snaked over a hill to the rig. On every side were unlimited quantities of nothing but sand and stones. In one caravan was the Mullard radio, call sign "Oboe Nine," and we took the opportunity of raising "Love Peter" just to see if the system really worked —it did. Bir Tlacsin was well established as camps went, having been erected in 1958, and even boasted a rather battered concrete tennis-court on top of the hill.

The "airstrip" consisted of a fairly flat stretch of the same sand and stone, and a tattered windsock. Apparently the standard test for an airstrip is to run a jeep up and down a dozen times and if it sinks up to the axles to go and look elsewhere.

A drilling rig at Bir Tlacsin.



A diagram of the IAL radio network for the Libyan Oil Companies.

The airstrip at Bir Tlacsin in the Libyan desert. The scenery—sand.

Breakfast over, and a quantity of freight transhipped, we took off in a cloud of dust and stones and set course for Laglas in concession 69.

In the desert there are no such things as base radio or navigation aids, and leaning over the pilot's shoulder it took me several minutes to find the dot in the distance which he assured me was the drill head.

If anything, the strip at Laglas was even rougher than Bir Tlacsin, and the Land Rover journey to the rig resulted in aching bones and a thick covering of dust over clothes, hair and skin. The Laglas rig was in process of being dismantled and gave us the chance to have a close look at some of the complex and expensive gear required for oil drilling. The camp was truly international, with Danes, Dutch, Americans and English and even a pet diminutive desert gazelle whose staple diet seemed to be *Lucky Strike* butts.

After consuming an excellent lunch we climbed into the bone-shaker and jolted our way to the aircraft to take off for Prakla Camp, 15 minutes' flying time away. Prakla houses a German geophysical company's survey team, who drove out to pick up their supplies from yet another dusty strip.

The journey back was uneventful, but as the desert brown gave way to homesteads and green-

The radio telephone in use at "Oboe Nine" Bir Tlacsin.

ery, and we thought of a long cooling beer apiece, the pilot executed a 180° about face and we were heading back. A company had informed IAL on the network that two lorries were overdue on the road from Garian, and Tripoli Aeradio had asked if we could have a look as we were airborne with plenty of fuel.

We followed the winding road for half an hour over the mountains south towards Garian but could find nothing apart from old ruins and the holes in the ground which house the troglodytes. Having concluded a fruitless survey, the aircraft turned once more for Idris and the long-lost glass of beer, while I pondered on IAL's radio lifelines to the desert and the men who spend their lives boring holes in the sand looking for gushers. ◆◆

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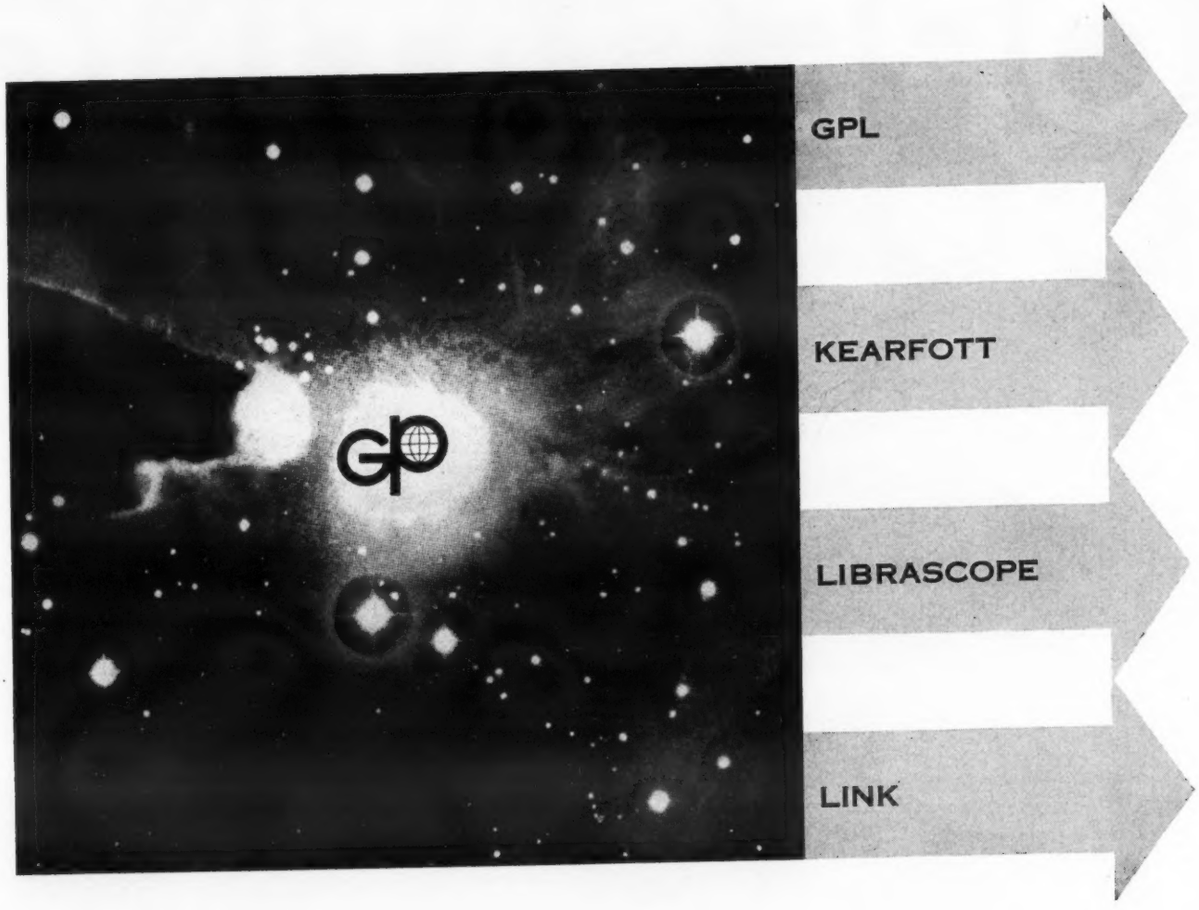

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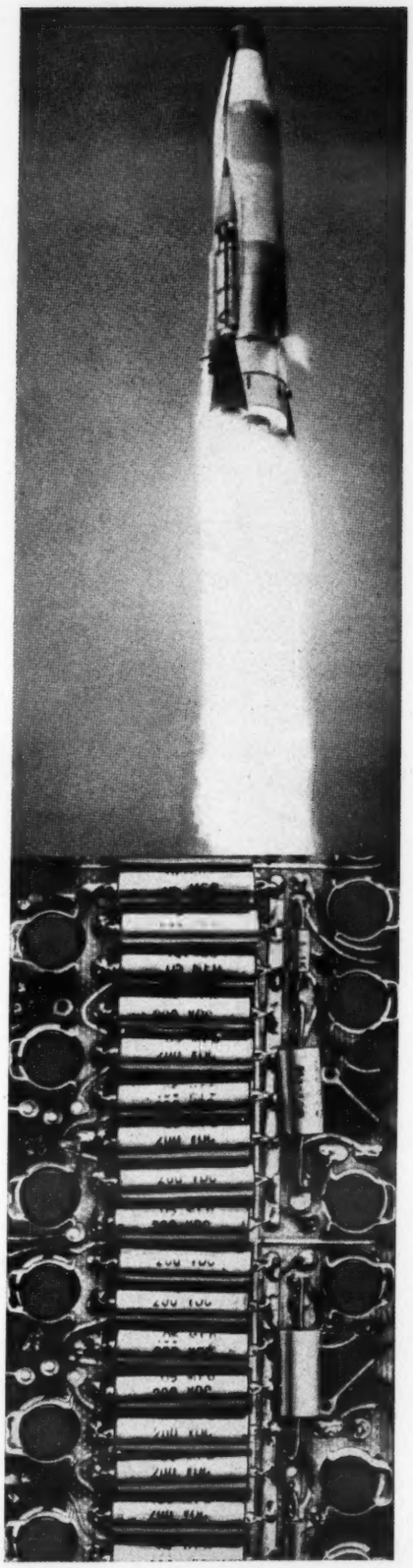

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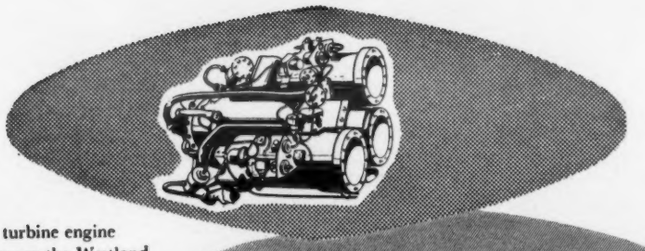
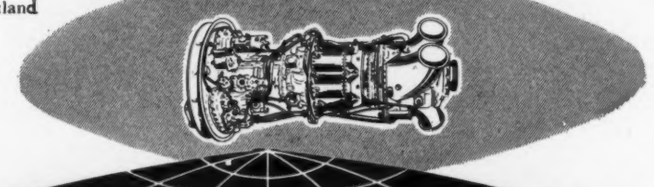
Exclusive export representatives (except Canada): Sterne, Carr and Farr Company, 425 Fourth Avenue, New York 16, N.Y., U.S.A. Cable address: "Staraero"



TRIPLE SCORPION an aircraft rocket engine which provides a source of extra power at all altitudes. Designed for sustained firing and long operational life.

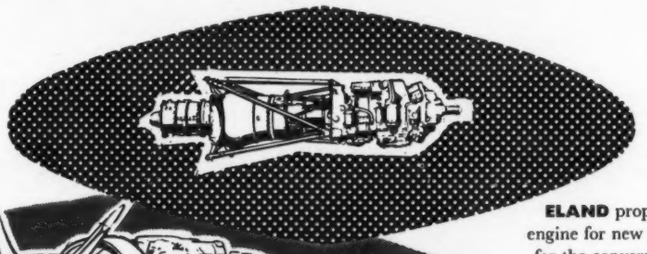
GAZELLE free turbine engine (1650 s.h.p.) powers the Westland Wessex and the Bristol 192. Now chosen to power the twin-engined Wiltshire.

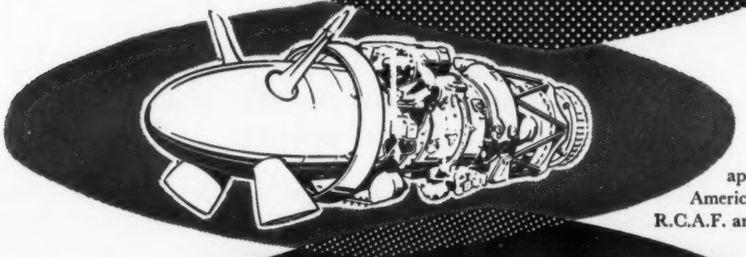


NAPIER AERO ENGINES

for the world

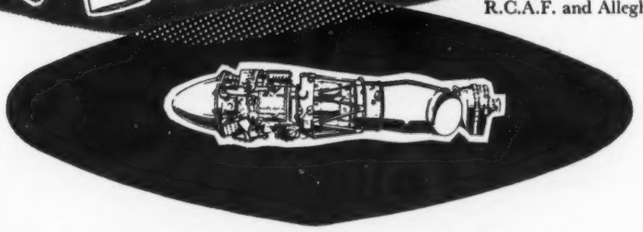
ELAND engines designed for the Fairey Rotodyne are basically the standard Eland with an auxiliary compressor mounted at the rear.





ELAND propeller-turbine engine for new airliners and for the conversion of piston engined airliners. The Eland which powers the Canadair 540 and Convair 540, is rated at 3,500 e.h.p. and is approved by British A.R.B. and American F.A.A. In service with the R.C.A.F. and Allegheny Airlines U.S.A.

ELAND engines for the Westminster are installed horizontally on top of the fuselage with a mechanical drive to the rotor shaft.



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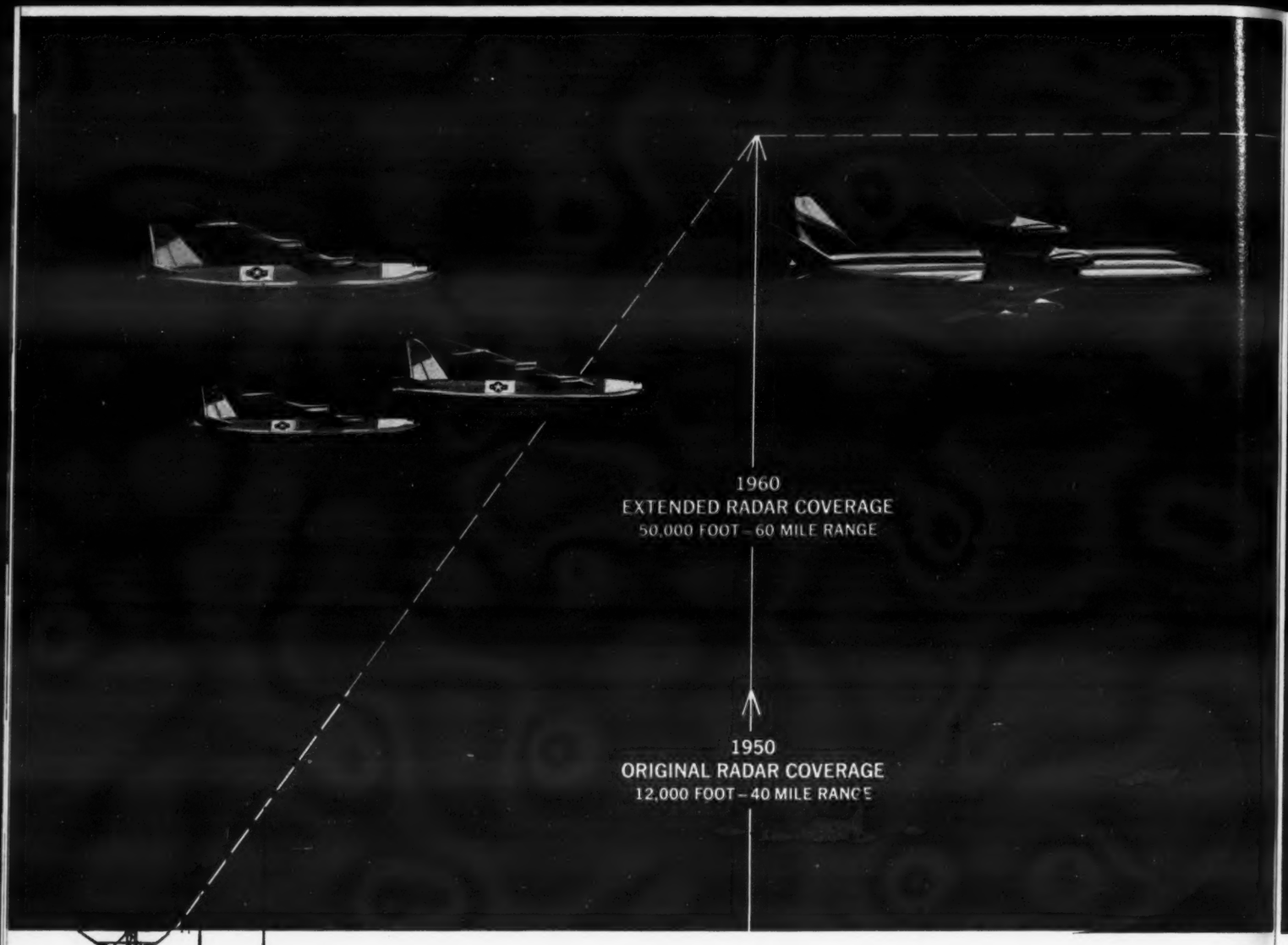
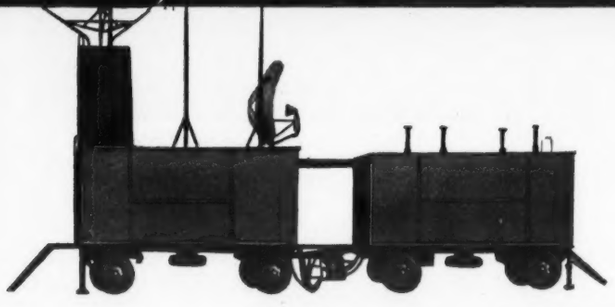
MORE AIRMEN LAND ON GOODYEAR TIRES, WHEELS AND BRAKES THAN ON ANY OTHER MAKE





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Gilfillan foresighted planning results in safeguarding flying personnel and aircraft *now*—by providing, *immediately,* extended coverage vital for jet aircraft safety.

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Maximum Coverage at Minimum Cost

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Gilfillan ability to design for planned non-obsolescence is recognized and proven.

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Gilfillan's experience, foresight and manufacturing capabilities are available for complete research, development and production in the fields of Air Navigation, Electronic Countermeasures, Missiles and Instrumentation, Radar Trainers and Ground Support Systems.

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built in quantity
for the Italian Air Force

Max. level speed	440 kts
Mach number	0.8
Take-off in	1,180 ft
Landing in	920 ft
Climb to 20,000 ft in	5'48"
Ceiling	41,800 ft
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Pressure fuelling.

Ejection seats, operation synchronized with jettisoning of canopy.

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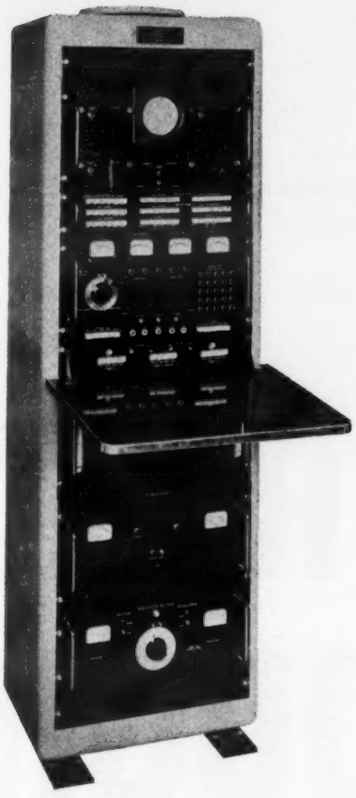


SFIM DEVELOPS ONERA TELEMETRY EQUIPMENT

In tests of missiles of all sizes and single-seat military aircraft, the basic flight parameters must be transmitted over long distances and recorded graphically, photographically and magnetically on the ground; the test engineer must also be provided with visual presentation.

O.N.E.R.A. (Office National d'Etudes et de Recherches Aéronautiques) has designed and developed a complete VHF telemetry chain.

S.F.I.M. has now acquired the licence to manufacture this equipment. The firm studies, develops and produces its various component systems and operates the mobile receiver and recording stations on behalf of the users.

S.F.I.M. telemetry equipment is now in current use by the French Navy, the Government Flight Test Centre, G.A.M.D., Nord-Aviation, Sud-Aviation, etc., and has played its part in a number of comparative tests made by the automobile industry.

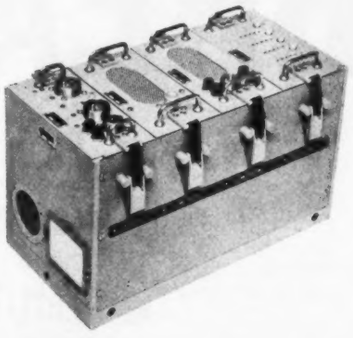
Main characteristics: 5 channels operating continuously and simultaneously.
Passing band: 400 c/s

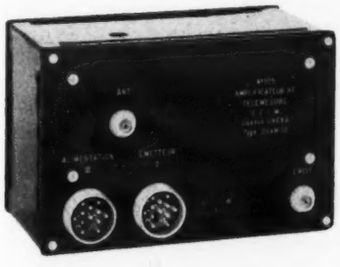
Frequency in the 100 Mc/s and 250 Mc/s bands.

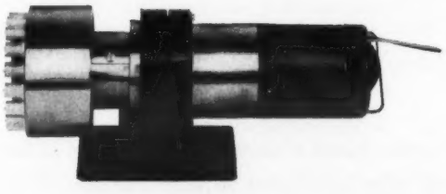
Component units:

Airborne:
- 5-channel transmitter
- pick-ups for pressure, linear and angular movements, acceleration, temperature, galvanometric measurements
- 15-channel commutator, passing band per channel 10 c/s

On the ground:
- receiver
- control cabinet
- decoding cabinet
- photographic recorder







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A MAJOR BREAKTHROUGH

- Push button navigation between any two points regardless of the location of ground stations
- Left/Right indication of track with distance to go
- Distortionless pictorial presentation
- Auto-pilot coupling

After years of persistent research we now announce this major breakthrough in electronic technology. Resulting from a revolutionary mathematical approach we have developed the Omnitrac computer—light, compact and reliable, Omnitrac converts hyperbolic or other position lines into rectilinear co-ordinates.

Based on a "master" map of the world, Omnitrac correlates navigational data of no matter what nature—Hyperbolic, Doppler, Inertial, Rho-Theta or Dead Reckoning for a single undistorted pictorial display with automatic chart change.

Omnitrac provides *all* the facilities and advantages of high accuracy hyperbolic systems *plus* push button navigation with left/right meter presentation and distance to go between any two points regardless of ground station location. This amounts to having an infinite number of point source beacons situated exactly where they are required for any journey, with either meter or pictorial presentation or both.

Omnitrac, by reducing all data to rectilinear co-ordinates related to a master grid, provides guidance information for the auto pilot.

Omnitrac, developed by The Decca Navigator Company, the only company in the world specialising in navigation systems, provides *all* the facilities required for jet age navigation.

DECCA

THE DECCA NAVIGATOR COMPANY LTD LONDON ENGLAND

The Rationalization of Air Traffic Control in Europe

Air traffic, both civil and military, is closely allied to a ground organization which is continuously available to provide aircraft with the assistance they require to complete their journeys with the utmost safety and economy.

This organization is continually undergoing improvement so as to provide a greater degree of support, and it must be adapted to the development of the aircraft. When this rate of development is steady the modernization process can keep in step without difficulty, but if by chance aviation techniques make a rapid advance the ground organization becomes suddenly outpaced and vigorous measures become immediately necessary.

The advent of the jet transport aircraft has occasioned a violent alteration in the pattern of development and the impact has been felt in all the ground services allied to commercial aviation, from airports and runways to air traffic control and navigational facilities along the airways.

The existence of air transport depends on the ability of the operators to make profits. The commercial jet aircraft is equipped with engines which have stupendous thirsts below a certain optimum cruising altitude, and this altitude lies in the upper levels of the atmosphere. The jet aircraft is therefore unprofitable unless it flies high, but this introduces a multitude of problems. In the first place the civil aircraft enters a domain which until now has been the preserve of military aviation. Secondly, the air traffic aids and control facilities which exist today to assist aircraft in flight, do not fulfil the requirements of high altitude traffic as the upper limit of their coverage lies around 20,000 feet.

The necessity of providing air traffic control at altitudes which may attain 40,000 feet has engaged the attention of experts throughout the world, and the problem has been resolved in relationship to the conditions which obtain locally. One feature remains common throughout, however: the simultaneous presence of military and civil aircraft in the upper levels of the atmosphere.

Thus, at the beginning of 1958, in preparation for the entry of jet aircraft into operation, Europe, or in this case the members of the Common Market, envisaged the unification of the air traffic control services throughout the continent. Commenced by Belgium, the Federal German Republic, Luxemburg and the Netherlands, the work continued with the participation of France and Italy and finally the United Kingdom. The international organization which will be responsible for the entire control of air traffic throughout Europe will be named *Eurocontrol*.

The objectives

This future organization for European air traffic control will be responsible for the safety of aircraft flying at high altitudes.

As the undertaking must develop progressively, the starting point consists of the facilities which already exist, namely a control system covering the lower altitudes based on the procedures standardized by ICAO and applied by the various countries on a national basis.

This system is formed by the interlinking of a certain number of flight information regions, each one being subdivided into control zones extending up to an altitude of 20,000 feet. This structure has been satisfactory up to the present as civil aircraft operated below 20,000 feet, while military aircraft flew at higher altitudes.

The appearance of commercial jet aircraft has rendered the system obsolete, as these aircraft, to be profitable, must enter the higher altitudes where high-speed military aircraft are operating. At these altitudes visual flight rules are no longer applicable, for speeds are such that the pilot's reflexes are too slow to permit avoidance manœuvres. It is necessary, therefore, that arrangements be made to ensure that the flow of traffic above 20,000 feet is under instrument flight rules.

As a result of a study carried out by the Coordination Committee for European Airspace (CEAC) of NATO and ICAO, the first provisional step has been taken. This is the creation of upper level control areas through which are defined the routeings or airways to be followed by transport aircraft flying over Europe. But these areas do not extend above 25,000 feet, with the result that though they can provide control for certain turboprop aircraft they cannot fulfil the requirements of jet aircraft which require control facilities up to 40,000 feet at least.

In the meantime the following considerations must be taken into account in the preparation of a future unified system.

a) By virtue of their speed, jet aircraft have reduced the relative dimensions of the flight information regions to the extent that it is not possible to employ the same boundaries for the upper flight information regions as for the existing lower regions (which a jet aircraft traverses in 10 or 20 minutes). It is also desirable that the transfers of an aircraft from one control centre to another should be reduced to the minimum.

b) The separation of civil and military traffic being impossible as it is prejudicial to the interests of either the one or the other, it is necessary to formulate a common air traffic control system for the upper airspace, a system which will be integrated with the existing international military organization, established within the framework of NATO and already designed for high altitude control.

c) The single international system should be able to make the maximum use of existing or projected military and civil installations. The provision of new facilities should be a common undertaking in order to avoid unnecessary expenditure.

The organization

The present framework of air traffic control is divided into a certain number of national lower flight information regions (3 for Italy, 3 for France, 1 for Belgium, 1 for the Netherlands and 3 for the Federal German Republic) which are grouped provisionally into a number of upper flight information regions to cater for the requirements of the still relatively light traffic travelling above 20,000 feet. These higher regions are termed UIRs (Upper Information Region) and are distributed as follows: 1 for Italy, 1 for France, 1 for Belgium, 1 for the Netherlands, 1 for Germany and 1 for the South of the United Kingdom.

As regards the proposed international system of upper information regions, whose dimensions must be compatible with the operational requirements of jet aircraft, the study group has suggested the division of Europe into two UIRs: the Southern UIR coincident with the provisional Italian UIR and comprising the upper airspace covering the Flight Information Regions of Rome, Brindisi and Milan with a Centre in Rome; and the Northern UIR covering the Flight Information Regions of France, Belgium, Luxemburg, the Netherlands and the German Federal Republic, the Centre of this UIR being Luxemburg.

In the case of the Northern UIR, in order to comply with military requirements in this sector, it is proposed to subdivide it into a Central UIR (France) and a North Western UIR (Belgium, Luxemburg, Netherlands and German Federal Republic); the Centres of both these UIRs will be in Luxemburg. A further UIR with the Centre in London will cover the southern part of the United Kingdom.

The organization of these upper regions will be such that the aircraft described as *general traffic* (subject to the rules of ICAO) will travel on predetermined routes or on a limited number of airways which will be as direct as possible. These routes or airways will be controlled, that is to say that the aircraft will be obliged to follow instrument flight rules. As for aircraft belonging to the *operational air traffic*, they will obey their own special regulations.

The coordination of high altitude operations will be achieved by the application of the following principles: 1) The general and the operational traffic will be controlled by separate organizations which will work in close cooperation (the terms of reference of these organizations will be clearly defined). 2) The control organization for the general traffic will be centralized, the criterion being an efficient coverage of as wide a range as possible so that the control can handle a large geographical area. On the other hand the control of the operational traffic will require zones of far lesser area. 3) The boundaries of the UIRs will be defined in such a way that they will contain zones reserved exclusively for the handling of military traffic.

The means

The organization termed Eurocontrol will have the status of a financially autonomous international public service, and will have as its object the establishment and operation of the necessary means to accomplish the following:

— prevention of collision between aircraft.
— the regulation of air traffic to ensure a rapid and ordered flow.
— the supply of information to aircraft, essential to safety and economy in operations.
— the alerting of search and rescue services.

In order to carry out these tasks it will be necessary for Eurocontrol to be equipped with the most efficient communication services. These fall into two groups, fixed and mobile services.

Fixed service

This consists of the communication service for the exchange of messages (control, weather, etc.), between the Centres of the UIR, the lower level Flight Information Region Centres and the military units. It is composed of telephone, teleprinter and telegraphic networks. During the first phase of the establishment of Eurocontrol, the best possible use will be made of this equipment, but it will have to be adapted progressively, so that it can be integrated into the automated system which is the final objective.

Mobile service

This consists of the various facilities which provide radio communication between the aircraft and the ground. Both the control of air traffic and its navigation aids are dependent on these facilities.

In the case of air traffic control it will be appreciated that this is based on information concerning the position and route progress of the aircraft. The controller uses this information to build up a continuous picture of the situation in his sector. To do this he employs flight progress strips which are continually being brought up to date, and a radar situation display.

The organization of Eurocontrol will not be finalized for several years.[1] The use of specialized computer systems which are at present undergoing development offers the possibility of entirely automatic processing of flight information derived from radar sources.

To sum up, pending the opening of the high altitude traffic control centres, namely within two to three years, the means available will be the following:

1. Direct RT communications between the controller and the pilot of the aircraft.

2. Complete radar coverage from the control centre, together with links for the transmission of radar information for remote stations to the centre.

3. At a later date, a navigation aid combined with an airborne transmitter which passes the flight information to an electronic computer at the control centre.

Navigation systems

Together with the air traffic control facilities, a network of navigation aids exists in the European-Mediterranean region. The navigation system adopted for this area is the VOR. It is already apparent that this system is insufficient for high altitude navigation as it does not allow a reduction in the spacing between aircraft and it lacks the flexibility required for the routeing of aircraft being controlled. As the VOR will remain the sole navigational aid on the airways for some time, its improvement must be considered immediately. This improvement will consist of an increase in accuracy, a reduction in ground reflections which render siting difficult, and in the development of an airborne computer which will enable aircraft to travel on parallel tracks when distance measuring equipment (DME) is allied to the VOR. The addition of such a system (TACAN DMET) would be of the greatest value as the pilot would be capable of far greater accuracy in positioning, the control would be more positive and efficient and the traffic flow more rapid. As TACAN has been adopted for military use, it is obviously desirable that the corresponding installations should be sited close to certain VOR beacons to enable a common use to be made of the distance measuring equipment DMET.

Even with improvement in the near future, VOR will not provide a control system for the entire airspace, so that it becomes essential that a new system be studied, to enable every pilot to identify his position with the greatest accuracy at all times, irrespective of the altitude at which he is flying. At the same time, in order to facilitate air traffic control, it is desirable that some system be developed whereby an aircraft's flight reports can be passed automatically to the control without intervention by the pilot, either on a demand from control or according to a predetermined timetable.

Eventually the UIR will be entirely scanned by radar, the only means of maintaining a continual surveillance of the airspace.

As navigation aids and air traffic control rely on radio techniques it is essential the most satisfactory frequency bands are used for high altitude control. In these circumstances the complete coverage of the UIR by VHF and UHF is considered essential. This coverage has already been achieved on a national basis with a number of VHF frequencies and soon with at least one UHF frequency. It will be possible to satisfy the requirements of Eurocontrol with this network providing that it is reinforced.

At present Eurocontrol is still a project. If at the outset the organization is based upon the existing Flight Information Regions (FIR), above which will extend even larger UIRs, the facilities will be insufficient to control efficiently a traffic flow which combines both civil aircraft and military aircraft travelling at nearly sonic speeds. All concerned are convinced of the necessity of employing automation in air traffic control (passage of information, rapid determination of aircraft routeing, and the provision of a current situation display for the controller).

The working group having completed a study of the possibilities of Eurocontrol, a group of experts will undertake the formulation of a practical plan. Particular attention will be devoted to new methods of traffic control with special reference to automatic transmission of flight information. In order to do this an experimental unit will be set up to study the equipment to be employed.

The task of this group of experts will be principally:

1. To organize and deploy an experimental unit and to direct the experimental work.

2. To coordinate the methods and procedures in use in the national information centres of the seven countries.

3. To coordinate the civilian-military cooperation of the seven countries.

4. To work out projects directed towards the establishment of a European system of air traffic control, on the basis of the research carried out by the experimental unit.

The promoters of Eurocontrol are under no illusions as to the difficulties which must be overcome to enable this international civil-military organization to function; nevertheless, they have laid down a timetable according to which the finalized system could be put into operation five years after the conclusion of the agreement establishing Eurocontrol and the creation of the expert working group. The three UIR centres proposed in London, Luxemburg and Rome will, however, commence operations provisionally at the end of 1962. At the moment the preparatory work is completed, and the diplomatic negotiations necessary for the establishment of Eurocontrol can begin.

The various groups which have prepared the broad details of the organization have also established the cost. A sum of $8,200,000 will be needed for radar, VOR/DME installations, VHF/UHF radio and sundry automatic and semi-automatic telecommunication systems. The headquarters of Eurocontrol will be established in Rome.

The speeds of jet aircraft and the diminution of distances which they entail are gradually compelling the small national groups which constitute Europe to coalesce and become an integrated unit.

[1] The seven Transport Ministers concerned in the Eurocontrol project (" The Six " and Great Britain) will meet in Rome on May 6th to study the plans which were to be finalized by the technical group meeting in London on March 22nd. The Ministers are expected to make a final decision permitting a degree of implementation of the plans in July.

SIEMENS

Siemens Airport Lighting Installations Facilitate Take-off and Landing

The Siemens-Schuckertwerke design, manufacture and install the electrical equipment for complete airport lighting and control plants:

Lighting aids · Rotating beacons · Wind and landing direction indicators · Apron floodlights and signalling searchlights · Ceiling projectors · Power supply with remote control · Special airport cables · Starting rectifiers.

SIEMENS-SCHUCKERTWERKE AKTIENGESELLSCHAFT

BERLIN · ERLANGEN

Plessey

HF and VHF Aerial Multicouplers

PV14 SERIES and PV95A

Aerial multicouplers are now general practice in communications systems to decrease capital expenditure on aerials. Plessey has wide experience of HF and VHF communications systems and the multicouplers described below are manufactured to very high standards; they are in worldwide use by communications networks, the British Armed Forces, many NATO countries, Civil Aviation Authorities and Press agencies. Prices are competitive.

PV14 SERIES—HF AERIAL MULTICOUPLERS

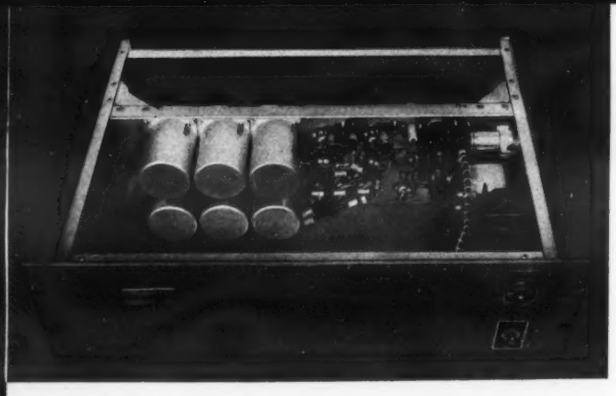
This equipment has been designed to meet the stringent requirements of both military and civil communication organisations, either from two aerials as a five-channel amplifier for diversity working or from one aerial as a ten-channel amplifier over the frequency band 2-30 Mc/s. The equipment is fully suitable for ground station or transportable use.

Specification

Frequency Range	2-30 Mc/s
Insertion Loss	0 dB+4.5 dB—3 dB over frequency range
Noise Factor	Maximum of 14 dB
Input & Output Impedance	75 ohms Nominal unbalanced
Regulation	A change in loading from 2 to 10 sockets will not reduce the gain by more than 3 dB.
Power Supply	105 V, 115 V, 200-250 V, 40-60 c/s a.c.
Ambient Temperature Range	—20°C to +55°C
Dimensions	19 in. wide x 5¼ in. high x 12 in. deep (48.3 cm x 13.3 cm x 30.5 cm)
Weight	28 lb. (12.7 kilos)

Features

- *Fully compensated* aperiodic amplifiers
- *Preset Switch* for dual diversity or single input operation
- *Low Noise Factor*
- *Minimum Cross Modulation*
- *Monitoring of each stage* by built-in meter
- *Low cross coupling* between output sockets.



PV95A VHF MULTICOUPLER

This unit again has been designed to meet various requirements over the VHF band of 100 to 156 Mc/s and provides outputs for up to six receivers when fed from a single aerial. In the design of this equipment, emphasis was placed on low noise factors and minimum cross coupling, using the wide band amplifier technique. The equipment is designed for ground station or transportable use.

Specification

Frequency Range	100-156 Mc/s
Insertion Gain	Greater than 10 dB over the whole range
Noise Factor	11 dB or less 100-108 Mc/s 10 dB or less over rest of range
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The Boom in Business Aircraft in the U.S.A.

By A. W. Parkes, Ballantine Laboratories, Boonton, N. J.

More flight hours per year with adequate Communication and Navigation Equipment

The past five years have witnessed the fastest growth in the use of aircraft for strictly business purposes of any period in aviation history. This has been due not alone to the growth in business during this period, but to the realization on the part of business managers that an aircraft is just one more tool which they can use to increase their operating efficiency. Many large organizations in the U.S. have decided to break up their operations and spread them around the country. They don't want to be the one organization in a small city that is responsible for 70 percent or more of the employment, hence they branch out. But top management must always be in close touch with each division, and here is where the business aircraft serves a purpose akin to an automobile for local transportation. General aviation is the term usually applied in the U.S. to aircraft activities not military and not scheduled or charter. This category includes approximately 7,000 multi-engined aircraft and 80,000 single-engined aircraft. Most of the multi-engined aircraft are owned and operated by business organizations, in addition to possibly 10,000 of the single-engined aircraft.

In 1958, 1959, and 1960, some 700 to 1,000 twin-engined aircraft will have been manufactured per year and sold mostly for business uses. Why has there been such a surge in the use of aircraft for business? It is because a real need is being filled by an aggressive aircraft industry, from the airframe manufacturer to the engine manufacturer to the instrument and accessory manufacturer, and of course to the aircraft electronics manufacturers.

With minimum communication and navigation (C & N) equipment, flights must be delayed or terminated when weather conditions along the intended path look questionable. It is easy to see that the loss of a few such days may cost a corporation far more than that of adequate C & N equipment. Commercial air transportation today would be far behind its present state if it were limited to fine weather flying along its entire route!

So today within the continental U.S. of 3,020,000 square miles (not including Alaska) we have 657 full powered VOR (visual omni-range) stations, 89 terminal or low-powered VOR stations, 204 complete ILS (instrument landing system) installations, 332 LF (low frequency) four-course range stations, 400 LF non-directional "homer" stations, plus hundreds of broadcast stations. These are so widely distributed over the U.S. and taken so for granted by all pilots that it would be extremely difficult to find a town large enough to have an airport that was not served by one or more of the government operated services or by a local broadcasting station.

There are many off-airways areas where the work-horse of all air navigation aids, the ADF (automatic direction finder), is valuable. There is nothing quite so simple to learn to use as an ADF, and because it can be used on almost any known ground station in its frequency band, usually 190 kc/s to 1,750 kc/s, it is a prime navigational aid regardless of what else is installed in the aircraft.

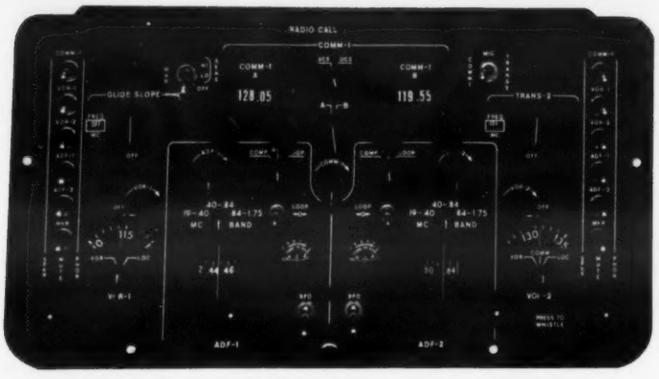
The ARC Type C-77C Control Unit. Designed for the recommended communication and navigation equipment on a light twin-engined aircraft.

Navigation is so easy today that I'm afraid if a modern pilot lost his "Jeppeson" manuals he'd really be lost even if he had some good maps right on his lap! This is, of course, a bit exaggerated, but not much.

Shortly after World War II, business aircraft were equipped with VHF communication equipment having 5 to 10 frequencies, which soon became inadequate. Today 360-channel equipment is common. The design of this is now such that it costs so little more than the 90 or 180-channel equipment that at least one major manufacturer stocks it solely. He calculates that by doing so he can sell the 360-channel equipment for less than he could sell the 90 and 180-channel equipment if he had to stock all three.

Communication with ground stations is almost entirely on 360 channels of very high frequency between 118.00 and 135.95 megacycles. Limited operations in limited areas of course require only a few frequencies, but if one plans instrument flights into busy areas all over the U.S. it is better to be equipped with full 360-channel coverage with a back-up for emergency and for quick changeover purposes. Very little use of the frequencies from 2,000 to 9,100 kc/s is made in the U.S. Aircraft that expect to fly across the Atlantic or Pacific, or in some foreign countries, usually are equipped with a transmitter-receiver covering several frequencies in this band. The reason for this is that transmission and reception on these frequencies is not limited to line-of-sight distances. If the proper frequency is used, and other conditions are right, it is possible to send and receive over distances of 500 miles or more.

VHF communication in the 118 to 136 megacycle (Mc/s) band in general is limited to line-of-sight distances. As a rough guide to the distance for VHF communication, one may use the following formula: D miles = $1.2\sqrt{H}$ (feet). From this we see that D in miles is 120 if the height H in feet is 10,000. VHF will generally be more reliable within its operating range than will HF because VHF will be more free from static than HF.



The ARC Type C-78A Control Unit provides a centralized control panel for installation on board aircraft carrying a co-pilot.

Dual airborne C & N facilities for IFR flying are considered by experienced pilots (and all commercial airlines) to be imperative. In *Table I*, examples 7 and 8, you will note that the 360-channel VHF communication equipment is "backed-up" by a 360-channel transmitter and by either of the two VOR/ILS receivers. The VOR receivers are duplicated. The Glide Slope and Marker Beacon receivers are not shown in duplicate, and this apparent error may be criticized severely by some on the general principle of duplication for safety. Duplication is recommended if the weight and the space can be tolerated. These receivers have been omitted only because a corrected altimeter, a rate of descent instrument, and a clock will normally be available as a "back-up" for this emergency.

Navigation facilities in the U.S. include not only the ILS at all major cities, VOR stations along airways, LF ranges for four-course flying or for DF'ing by an automatic direction finder (ADF), and hundreds of non-directional "homer" stations for use with the airborne ADF, but the government has installed radars at many busy airports. These radars can be called on for homing information in emergencies. Of course they act as monitors in busy areas to increase the overall safety. In many locations VHF ground direction finders have been installed to help locate aircraft in an emergency. Most aircraft that plan to do instrument flying in crowded areas are equipped with two receivers capable of spotting an LF range, a homer, or an inner or outer marker on an ILS. They also have two VHF communication sets which are used simultaneously.

I have gone into the details of the communication and navigation (C & N) facilities because I want to stress that, without these, even the very best aircraft available would be of such limited usefulness as to be uneconomical. *The increased number of safe operating hours per year made possible by a modern installation of C & N equipment is so great* that the initial cost of the C & N becomes a minor factor. The flights that would otherwise have to be delayed due to uncertain weather and the inability to file or change flight plans would be very costly and annoying. This would result in a slowing down in the use of aircraft as a business tool. We believe the reasons for the phenomenal growth in the use of aircraft for business can be summed up as follows: (a) Good business conditions, (b) imaginative engineering and aggressive sales promotion, (c) far-sighted planning of communication, navigation, and traffic control facilities on the part of the Federal Aviation Agency, and of course (d) the availability of a wide choice of airborne C & N.

By a "wide choice of C & N" we mean immediately available equipment to meet the needs of aircraft from the multi-engined unit flying under instrument conditions in dense traffic areas all over the U.S. and abroad, to the smallest single-engined aircraft that may be used only locally in sparsely settled areas and only under conditions of good visibility. *Table I* shows the wide range of C & N equipment we believe suitable for eight different conditions. It will be noted that the greatest increase in C & N equipment requirement comes with the decision to fly by instrument flight rules (IFR). Under these conditions, multiple navigation and multiple communication equipment is *extremely* desirable not only for safety in case of malfunction of one, but for simultaneous use of more than one navigational aid. Localizer, glide slope, markers, VOR, and beacons are often used simultaneously.

A single pilot flying any aircraft under IFR can be an extremely busy man, *particularly* if he is under-equipped with C & N of the most reliable type. He finds it necessary to change frequencies of both C & N equipments often when he is busiest. For this reason, experienced instrument pilots in the U.S. today are requiring far more C & N equipment than was thought reasonable or feasible five years ago.

The "reasonability or feasibility" of having a complement of C & N equipment as shown in *Table I* for IFR in heavy traffic areas has become much less of a problem than it was even five years ago. Today, a high-powered (15 to 20 watts) 360-channel VHF

By using standard sized units a wide range of communication and navigation equipment can be assembled at low cost. This typical selection can be amended to suit the user's requirements.

A compact control unit for use in aircraft that are not employed for instrument flight in high density areas. This is the ARC Type C-70E.

TABLE I

RECOMMENDATIONS FOR MINIMUM AIRBORNE COMMUNICATION AND NAVIGATION EQUIPMENT (C & N EQUIPMENT)

	VHF Comm. (Rec. & Transmitter 5 to 10 channels)	VHF Comm. (Rec. & Trans. 40 to 90 channels)	VHF Comm. (Rec. & Trans. 360 channels)	VHF Trans. (360 channels)	HF Comm. (Rec. & Trans. 4 to 12 channels 2000-9100 kc/s)	Automatic Direction Finder (ADF) 190-1750 kc/s	VOR/LOC (visual omni-directional range receiver and localizer) 108-127 Mc/s	Glide Slope Receiver	Marker Beacon Receiver, 3 lights plus audio	Headsets	Cabin Loudspeaker System	Microphones	Interphone to co-pilot, or announcer to passengers	Course Director for VOR/ILS	Notes
1. Single engine aircraft flying within the U.S.A. under visual flight rules (VFR) in areas where there is little air traffic.	1	0	0	0	0	1	0	0	0	2	1	2	0	0	A VOR/LOC Receiver may be added as "the next step."
2. Single engine aircraft flying within the U.S.A. under VFR but in areas of dense traffic.	0	1	0	0	0	1	1	0	0	2	1	2	0	0	No "back-up" communication provided here but one should be added as "the next step."
3. Single engine aircraft flying within the U.S.A. normally under VFR, but occasionally under poor visibility conditions and dense traffic.	0	0	1	0	0	1	1	0	1	2	1	2	0	0	No "back-up" communication provided here, but one should be added if at all practical.
4. Single engine aircraft flying always outside the U.S.A. normally under VFR, but occasionally under poor visibility conditions and all traffic density.	0	1	0	0	1	1	0	0	0	2	1	2	0	0	Note that VHF communication is "backed-up" by HF communication, but no "back-up" is included for the ADF. The addition of another ADF should be the "next step."
5. Single engine aircraft flying under VFR and Instrument Flight Rules (IFR), as required, both inside and outside U.S.A.	0	0	1	1	1	1	1	1	1	2	1	2	0	0	Note that both communication and navigation have a "back-up."
6. Twin engine aircraft flying within the U.S.A. under VFR in areas of light traffic and good visibility.	0	0	1	0	0	1	1	0	1	2	1	2	1	0	This would be an absolute minimum and would result in limited use of the aircraft.
7. Twin engine aircraft flying within the U.S.A. under VFR or IFR as occasion demands, in any area.	0	0	1	1	0	2	2	1	1	2	1	2	1	1	Note that both navigation and communication are "backed-up." The "back-up" for the VHF Transmitter/Receiver is a 360-channel Transmitter, plus either of the two VOR/LOC Receivers.
8. Twin engine aircraft flying under VFR and IFR, as required, both inside and outside the U.S.A.	0	0	1	1	1	2	2	1	1	2	1	2	1	1	Note that this differs from the last prior entry in that an HF communication set is added.

transmitter with a 360-channel VHF receiver with all mountings and controls weighs but 22 pounds, as in the case of Aircraft Radio Corporation's Type 210. Five years ago equipment with so many channels was not available at any weight and those with far fewer weighed 30 to 40 pounds. It is safe to say that there has been a 2 to 1 reduction in the weight of C & N equipment for full IFR operation during the past five years. C & N equipment for full IFR operation weighs a little over 100 pounds compared to over 200 pounds five years ago. An example of one piece of C & N equipment is the R-33A Marker Beacon Receiver by ARC. The current requirement from the 28-volt system is 0.35 amperes, compared with 3.0 amperes of only a few years ago for a receiver performing the same functions! Of course, part of this improvement is due to the use of transistors instead of vacuum tubes, though it will probably be another five years before all C & N equipment will be completely transistorized. Incidentally a well-designed transistorized replacement for a vacuum tube device is currently apt to be a bit more expensive in first cost. It is expected that this cost differential will not last for more than a couple of years. If the design of the transistorized equipment is good, and it is free from the harmful effects of transient voltages anywhere in the aircraft installation or the equipment itself, the maintenance problems should be markedly reduced. ARC's all-transistor 3-light plus audio R33A Marker Beacon Receiver has no moving parts to wear—not even relays.

With a single or dual installation of an automatic direction finder (ADF) it is possible to navigate almost anywhere aircraft fly, and be assured of obtaining bearings to known radio transmitters. Hundreds of low-powered coastal radio beacons, airways four-course ranges, high and medium powered non-directional beacons, and broadcasting stations all provide pilots with navigational information. Thousands of ARC's Type 21A ADF's are in use in aircraft from supersonic jets to 2-place helicopters. The complete ADF weighs under 20 pounds and is considered by many pilots the primary requirement for navigation, regardless of how much additional equipment he carries.

Nothing has been said in this article about weather radar, nor distance measuring equipment tacan (DMET) nor other devices such as transponder beacons that are beginning to find a useful application in business aircraft. Some of these have already proven their usefulness, but at the moment they are not used in business aircraft in great numbers.

The wide range of aircraft types and prices makes it possible for business men to experiment with aircraft in a small way to assure themselves that their particular business can profit by the investment. When the experiment is successful, the next step is a larger aircraft of the single or twin-engined type. Then the next step is, of course, to more aircraft, and with each step we have found goes a big increase in electronic communication and navigation equipment. This is because owners have learned of the increased safety and greater utilization made possible with a larger complement of C & N. ↔

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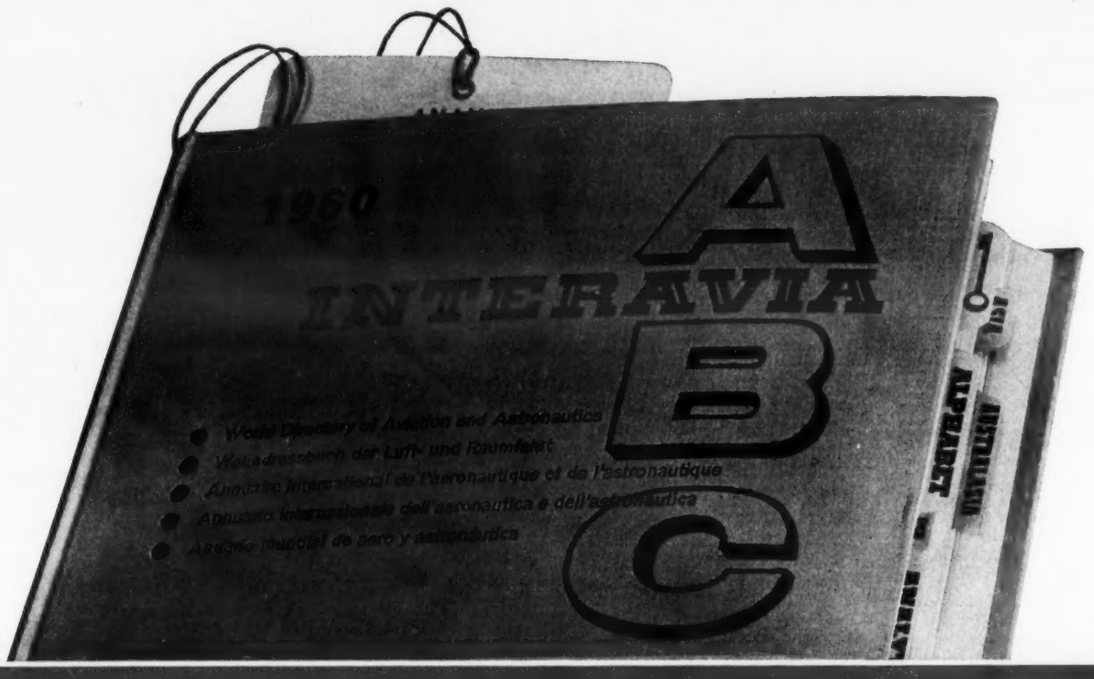

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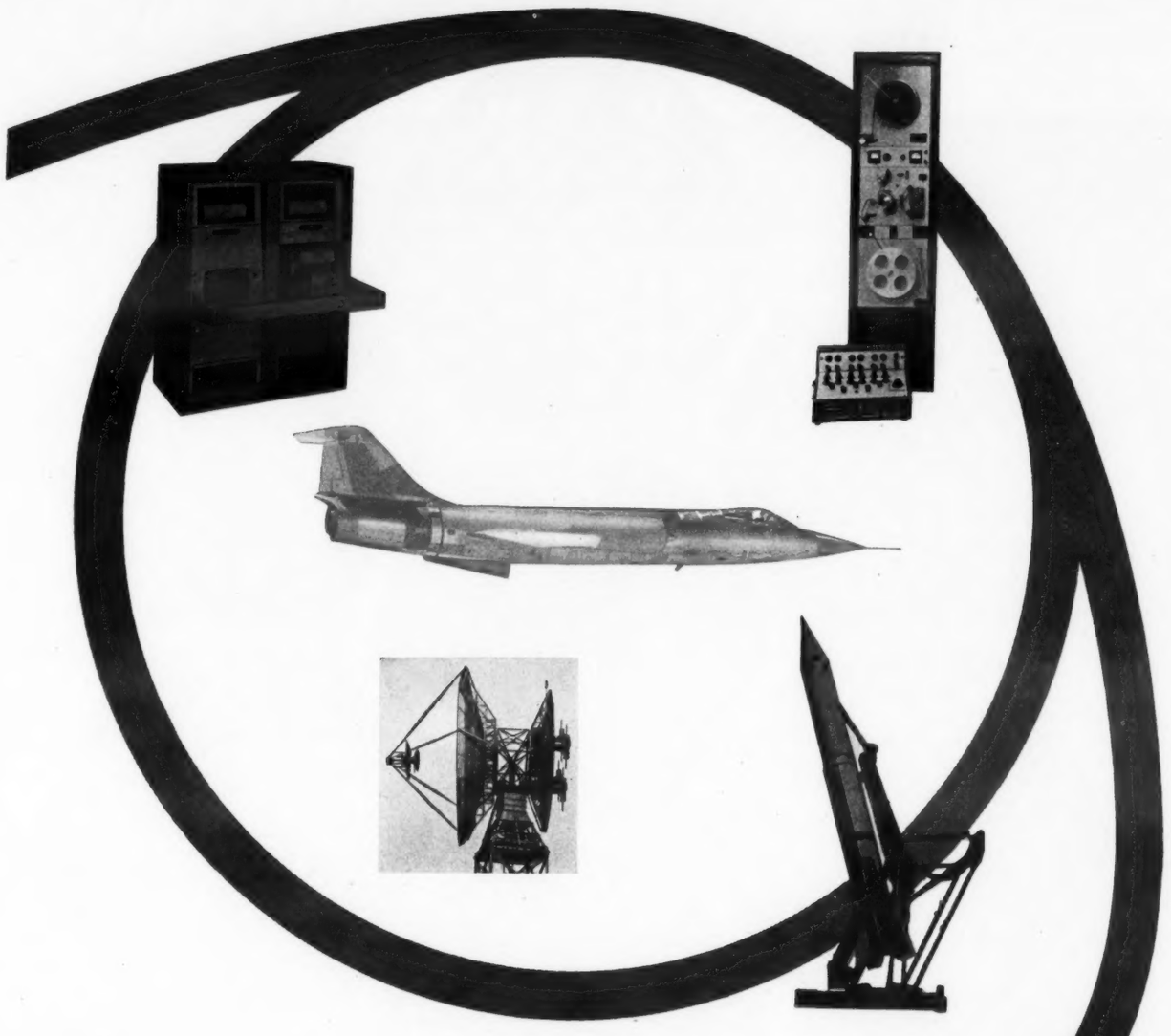

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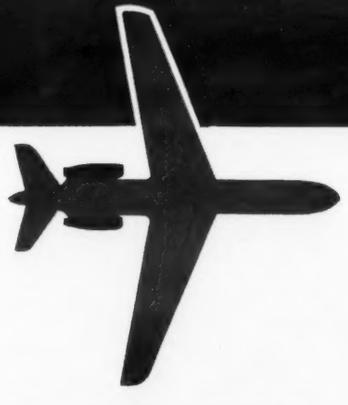

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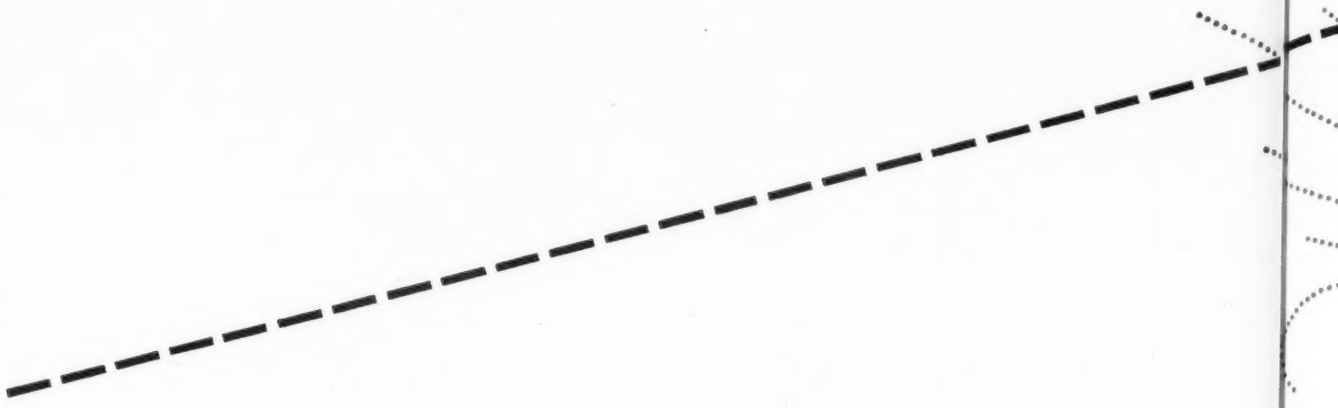

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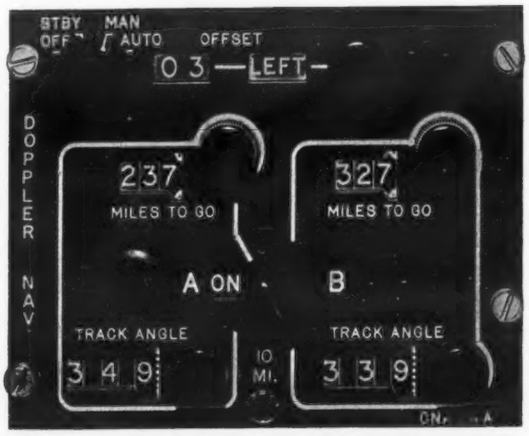

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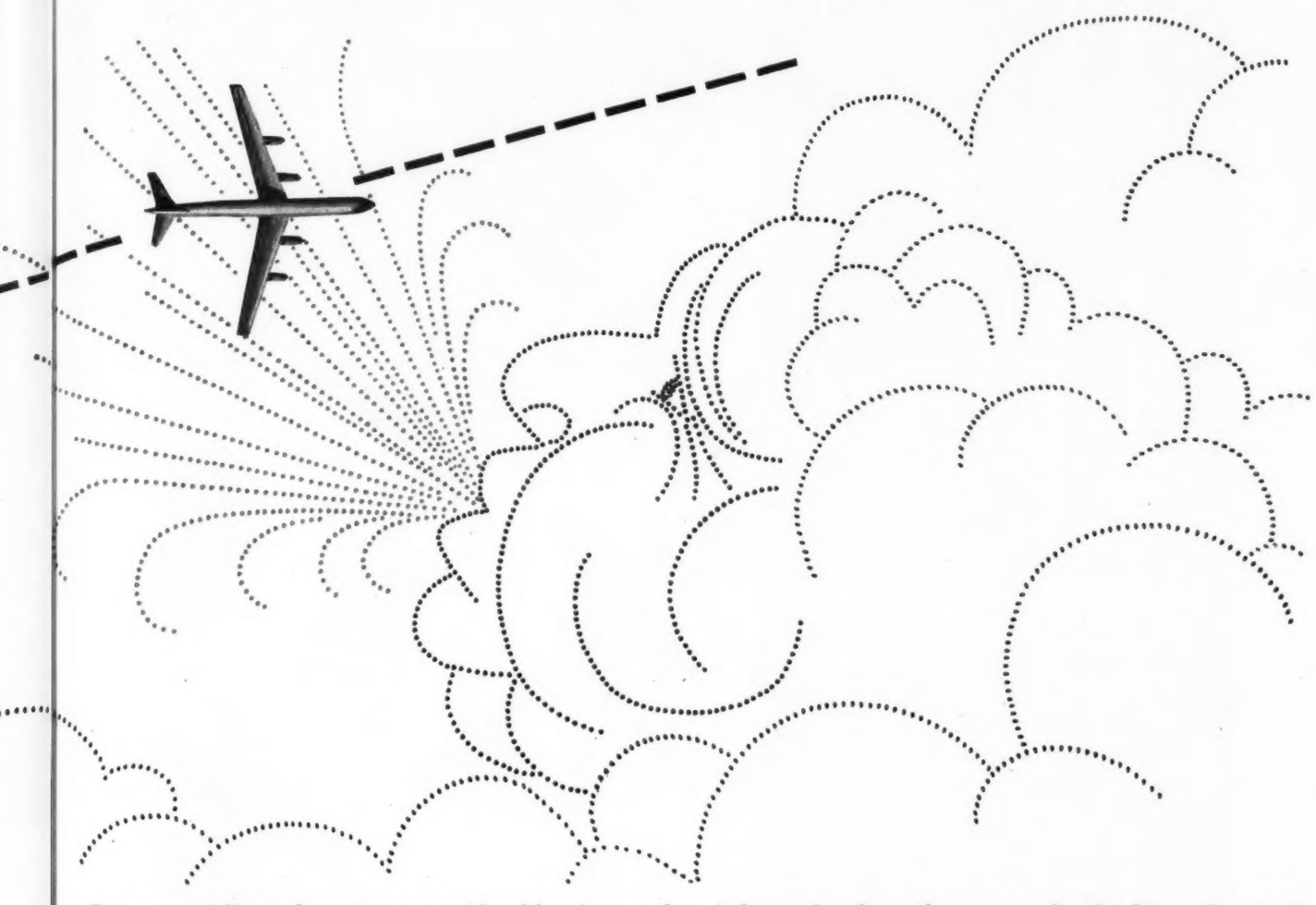

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The evolution of the *Mirage III*, in both its design and the specifications for its prototypes, is a prime illustration of the far-reaching changes which have taken place in strategy and tactics in the course of the past few years.

To trace the antecedents of the aircraft now being produced, we must go back to the years immediately following the Korean war. At that time combat aircraft were getting steadily heavier, more complex and hence more costly. And when faced with the restrictions and realities of war, American pilots often found that the equipment with which their aircraft had been packed served no useful purpose, merely adding to their weight and reducing combat performance.

Meanwhile, rearmament was getting under way in Europe, and countries were having to face greatly increased expenditures, despite substantial American aid.

Thus, for military, technical and financial reasons, was born the concept of the light interceptor and, on a more general level, of the lightweight combat aircraft. Full use was made of all the new technical resources (plastics, miniaturization) in an attempt at any rate to slow down the trend towards increasing weight and the bigger and bigger aircraft which the European countries could neither manufacture nor operate.

In the United States, Edward H. Heinemann of Douglas Aircraft was one of the champions of this effort at simplification and miniaturization, while in Britain W. E. W. Petter led the way with his Folland *Gnat*. In France, the Air Staff also decided to investigate the operational possibilities of this new concept.

The experiment was applied first to the light interceptor. A programme was drawn up for the design and construction of aircraft with small jets and a rocket group to supply the extra power needed for pursuit and engagement of air targets.

The advantages of these aircraft were that they were modest in weight and, despite their low power, had relatively high speed and climb performance.

On the other hand, they had a serious drawback: they were entirely dependent on ground sources for guidance to the air target they were supposed to destroy. They could, in fact, be considered as a kind of flying platform capable of rapidly carrying missiles to attack altitude and then returning to base. But the flight path to be followed had to be calculated with a high degree of precision by the ground station. Since it could not be integrated into a continuous control and guidance system, this class of interceptor would have had difficulty in engaging its target, and its operational efficiency would have been very low.

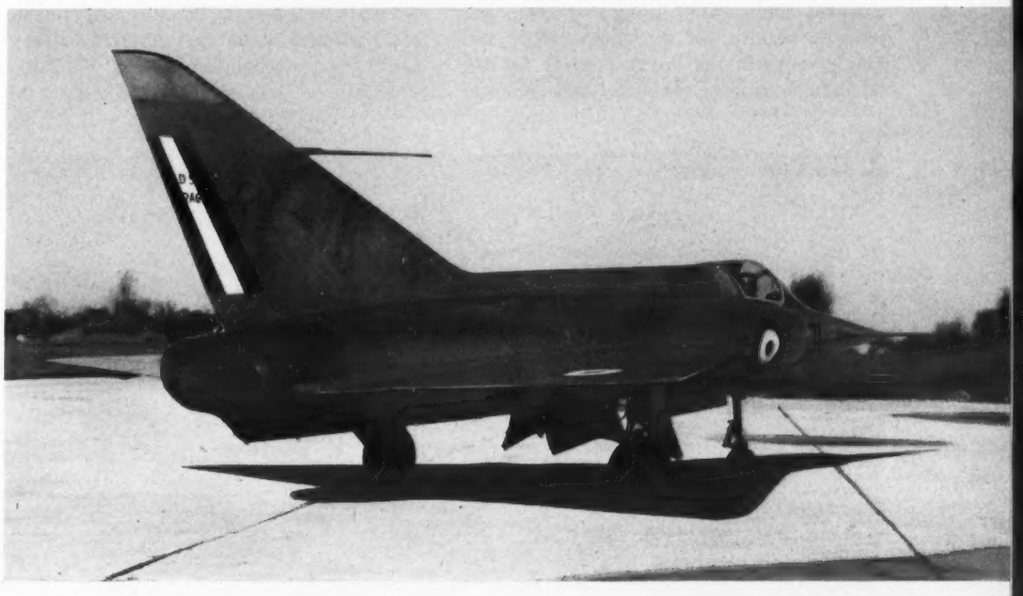
During the years 1952 to 1954, while conventional combat aircraft were being built in quantity, a number of manufacturers turned their attention to the design and construction of light interceptor prototypes. They included, in France, Sud-Est with the *Durandal* and Dassault with the *Mirage I*.

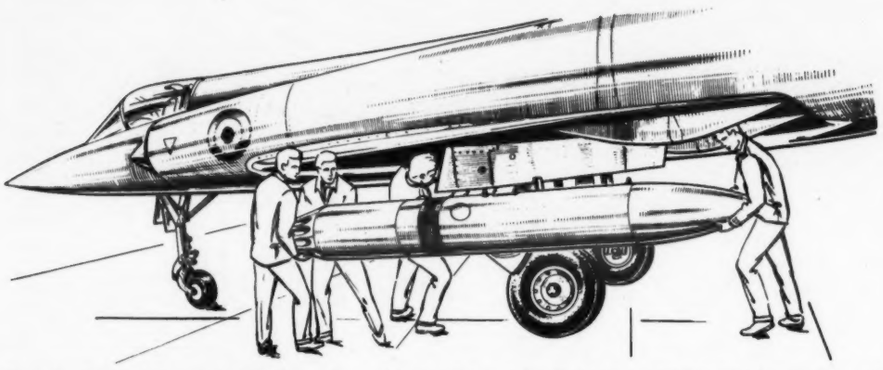
Late in 1954, however, Western strategy was considerably modified by suggestions from SHAPE and by the decisions taken by the Atlantic Council in December of that year. Until after the Lisbon conference, the military authorities had thought that Europe could be defended primarily by conventional means, backed up by the United States' atomic forces. But the strategists, economists and statesmen who met in Lisbon to discuss the problems of Western rearmament realized that, even with American aid, the European countries could not find the money or the men required for a purely conventional strategy.

It was at that time that General Ridgway and his successor General Gruenther were obliged to modify their initial plans and to rely more widely on the threat of nuclear retaliation for the defence of the Allied territories than on the use of conventional forces, since it was plain that the Free World could not provide the latter in sufficient numbers.

If the West based its security on nuclear reprisals, this meant that the potential enemy would not run the risk of attacking with conventional means, since he would know that any aggression would be countered with atomic weapons. If he did have recourse to

The Marcel Dassault MD.550 prototype (Mirage I) in its final configuration—with swept-back rudder trailing edge (instead of the earlier straight edge), eyelid afterburner flaps and a SEPR rocket engine beneath the fuselage re lb The aircraft, which was powered by two MD.30R *Viper* reheat jets with a maximum thrust of 2,150 lb each (1,650ar. without reheat), was the " ancestor " of both the single-engine *Mirage IIIC* and the considerably larger twin-engine *Mirage IV*, in which the jets are also placed side by side. The *Mirage II* was to have had more powerful Turboméca *Gabizo* engines in place of the two *Vipers*, but was dropped in favour of the SNECMA *Atar*-powered *Mirage III*.





Preparing for an airspace patrol mission. The combined rocket-container/fuel tank is of lightweight construction and can be handled without mechanical aids.

force, it could only lead to the use of atomic weapons on both sides.

This evolution in defensive concepts condemned the formula of the light interceptor even before it had taken shape in anything but prototypes. How could one accept an interceptor dependent entirely on the ground organization when the latter had become frighteningly vulnerable to thermonuclear blows? What was more, once the enemy's bombers would no longer be carrying TNT bombs but nuclear weapons, the defence lost a great deal of its point.

The first reaction was to abandon the light interceptor formula, return to earlier designs and existing prototypes, and attempt to improve their electronics equipment so as to make them less dependent on ground control.

The first *Mirage III* was born directly of this transformation. Fundamentally, it had a *Mirage I* wing, with a larger fuselage containing a more powerful engine and sufficient electronic equipment to reduce the need for ground assistance. This aircraft took to the air for the first time in November 1956 and after only a few flights reached speeds well above Mach 1.

Aerodynamically, the formula appeared to be better than its predecessor, i.e., better than the configuration using two low-power jets. As regards the electronics, there was ample room in the larger fuselage for the equipment required for target detection and fire control of the air-to-air missiles which the new *Mirage III* was designed to carry.

Work therefore continued actively on this aircraft, and the Government decided to build a pre-production batch to enable final developments to be completed before quantity production was organized.

Meanwhile the months were passing. August 1957 brought a fresh strategic revolution. This time it was brought about by Mr. Khrushchev, who announced the launching of an intercontinental ballistic missile capable of hitting a target some 3,000 to 5,000 miles away with an adequate degree of accuracy. Admittedly, both the United States and Russia had for long enough been working on ballistic missiles more or less derived from the German V2. But now the Soviets actually possessed a weapon against which there was virtually no defence, capable of attacking over vast distances and inflicting enormous damage. Intelligence sources also reported that the Soviet Union already had substantial stocks of shorter-range missiles and that most of the European countries lay open to the threat of these new weapons.

If air defence had lost a great deal of its value after the decision to use nuclear weapons if necessary, it became entirely valueless as soon as the threat ceased to come from manned bombers carrying atomic bombs but from ballistic missiles. The latter could fall on their targets at twenty times the speed of sound, and nobody yet knew how or if they could be intercepted en route.

This was the second revolution which led planning staffs on the one hand and manufacturers on the other to transform the interceptor into an offensive aircraft. On the other side of the Atlantic the Lockheed F-104, designed originally to be a pure interceptor for the defence of point targets, rapidly developed into an offensive combat aircraft, involving major modifications to the airframe, equipment and weapons.

The *Mirage III* followed the same line of development. The "C" model, which had originally been designed for air defence and interception at high altitudes, was modified to be capable of both defensive missions and of attacks on ground targets. Here it should be noted that the basic configuration of the *Mirage III* was particularly favourable to this transformation. Right from the beginning and long before the above-mentioned changes in European strategic concepts, this aircraft had been offered to the French Air Staff as a multi-purpose design, with special stress on its ability to perform a variety of different tasks with only minor modifications, most of them being made by the squadrons themselves. These tasks ranged from pure interception to ground attack, reconnaissance and light bombing. The delta wing was of great advantage here, since it gave a relatively low wing loading, a high degree of structural rigidity and finally space for the carriage of substantial quantities of fuel. Even the limitations from which French designers have always suffered as regards powerplants were turned to good account by Dassault's engineers. Since they had no engines of the power available to their British and American competitors, they were obliged to refine their designs to the utmost, and reduce the aircraft's drag so as to preserve the high performance considered necessary, despite power limitations.

For this reason the *Mirage III* airframe, when equipped with a jet of a power similar to that of equivalent American aircraft, has surprisingly high speed performance, with comfortably supersonic flight at altitude even without reheat.

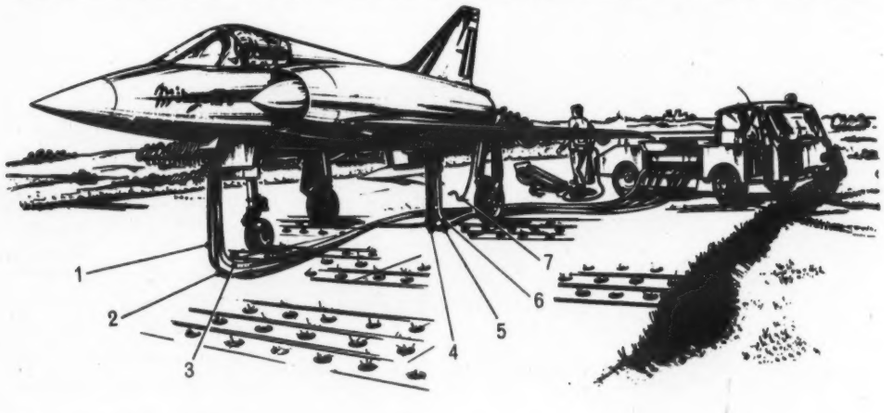
Finally, the fact that the aircraft was designed from the outset for a variety of roles means that it can be converted without difficulty from a pure interceptor into an offensive aircraft. The modifications required are for the most part limited to changes in equipment.

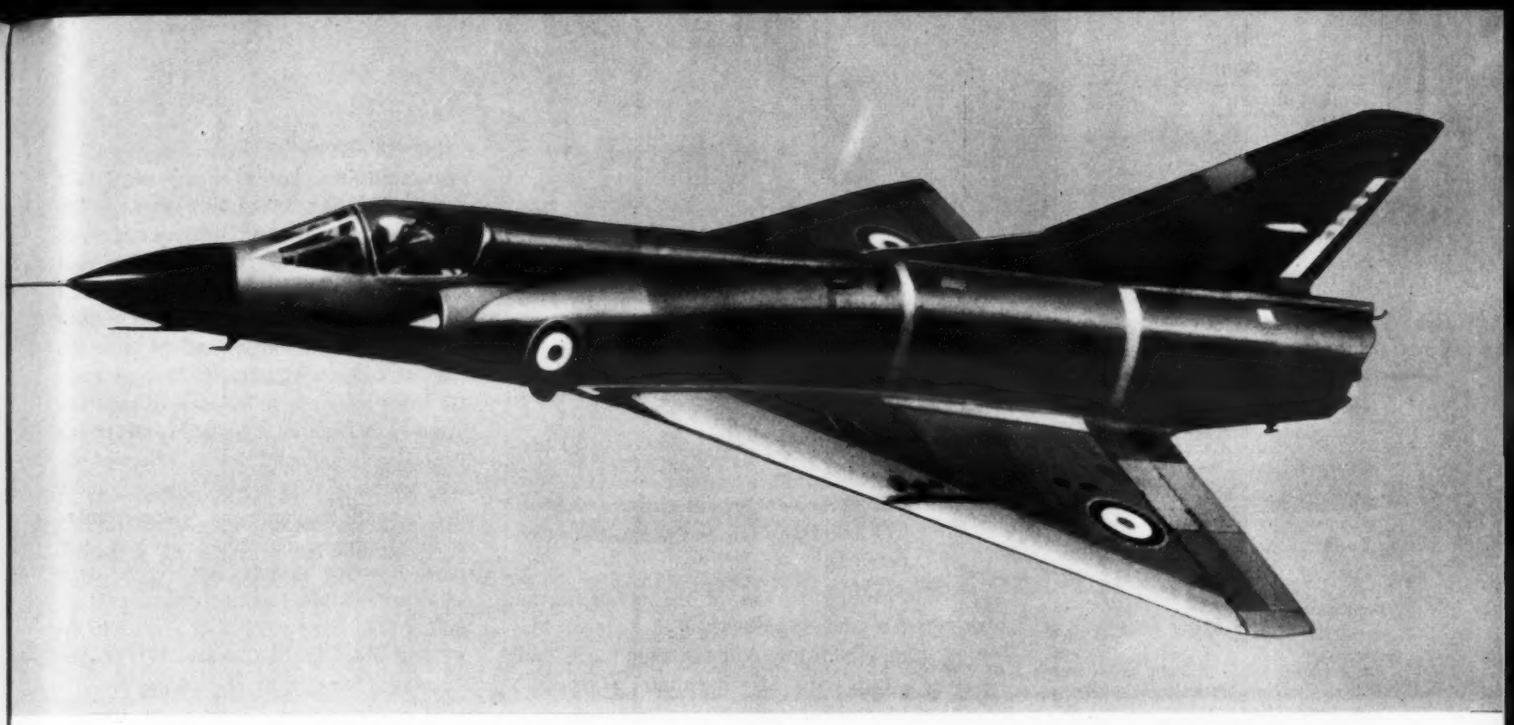
Such has been the development of the *Mirage III*.

*

This aircraft, however, is not the last of its family, since it has already been followed by the *Mirage IV*, France's atomic bomber, and may perhaps be followed again by a new lighter combat aircraft with even higher performance. ◆◆

Preparing for an alert take-off. 1. Radar range finder compartment ventilation return line; 2. radar range finder compartment ventilation suction line; 3. cockpit air conditioning; 4. a.c. cable; 5. d.c. cable; 6. air starting; 7. telebriefing.





• The Basic Design

As homing and guided missiles grow in efficiency and reliability from year to year, there is a proportional increase in the number of people who insist that the manned aircraft has no longer any future as a weapons system. But, for the time being at any rate, a "cease-fire" has been reached in the contest between the guided missile and the manned aircraft, and defence planners have adopted the formula of guided missiles *and* manned aircraft.

Although in the next few years the guided missile will gradually oust the manned bomber in strategic operations, the prospects of the manned aircraft as a tactical weapons system remain highly favourable, as a look at the large-scale procurement programmes of many lands will show. Although, given the present state of the art, the problem of designing a special guided missile for each tactical mission presents no difficulties, the cost would be disproportionately high compared with the destructive potential which could be obtained. It would be necessary either to provide homing, target detection and tracking equipment for the missile, together with the appropriate computers, stabilizers and servo-controls, or to subordinate the weapon to a complicated, costly and vulnerable network of ground radar stations.

The best solution to the problem is therefore almost self-evident: versatile and highly mobile manned weapons platforms to transport the weapons to the target, carrying missiles specially designed for the mission. To define the best marriage of missile and aircraft requires a great delicacy of touch. If the carrier aircraft contains too much electronic equipment, the weapons system will be cumbersome; if, on the other hand, too much control and guidance equipment is built into the missiles, then costs will soar upwards.

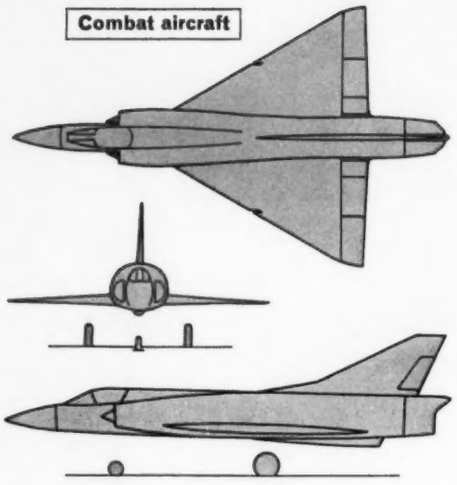
The minimum requirement of a modern tactical weapons system is its ability to perform the following missions: the interception of enemy supersonic bombers flying at high altitudes; support of ground forces; keeping the airspace clear over the combat zone; tactical attacks on ground targets in the combat zone and on the enemy's lines of communication; short-range reconnaissance. The problem is complicated by incidental requirements such as mobility, independence of vulnerable and costly ground bases, maximum operational readiness and, last but not least, a reasonable price.

These were the problems facing the engineers of *Générale Aéronautique Marcel Dassault (GAMD)* when they designed the *Mirage IIIC* weapons system.

• Past history

The first model to use the new formula, an experimental prototype designated *Mirage III-001*, made its maiden flight on November 18th, 1956 and was subjected to rigorous flight tests during the following two years. The results of over 200 accident-free test flights were so encouraging that a pre-production batch of ten aircraft was built, incorporating substantial improvements. These were as

A forerunner of the Mirage IIIC... still without radar. The JL 200 combined rocket launcher/fuel tank contains 251 U.S. gall. of fuel and carries 36 SNEB 68-mm rockets which are fitted with high-explosive warheads for air-to-air missions and high-penetration hollow charge warheads for air-to-surface missions. The rockets can be fired at a rate of over 1,500 per minute at all speeds below Mach 1.



Dimensions

Overall length	45 ft 5 in.
Wing span	27 ft
Overall height	14 ft
Wing area (incl. fuselage section)	374.6 sq.ft.
Wing leading edge sweep	60°
Thickness/chord ratio	3.5—4.5 %
Dihedral	—1°
Aspect ratio	1.94
Undercarriage track	10 ft 4 in.
Wheel base	15 ft 6 in.

Weights

Empty (with pilot)	13,200 lb
Fuel (kerosene)	
Internal tanks (depending on mission)	3,750—4,850+ lb
External tanks (depending on mission)	3,100—5,700+ lb
Rocket propellant	132 lb

Weapons

SNEB 68-mm unguided missiles	18 or 36
1 bomb	1,100 lb
1 nuclear bomb (hypothetical weight)	1,100 lb
1 Nord 5103 air-to-air guided missile	300 lb
1 MATRA 511 air-to-air guided missile	400 lb
2 *Sidewinder* air-to-air guided missiles	300 lb
1 *Firestreak* air-to-air guided missile	300 lb
Take-off weight, fully equipped, depending on mission	17,600—24,200+ lb

Powerplant

Main powerplant SNECMA Atar 9C	
Sea level static thrust without reheat	9,370 lb
Sea level static thrust with reheat	13,200 lb
Thrust in stratospheric flight at speeds above Mach 1.4 corresponds to a SL thrust of	14,100 lb
SEPR 841 auxiliary rocket powerplant	
Thrust (two alternatives)	3,300 or 1,650 lb
Total impulse	3,300 lb × 80 sec

Performance

Max. speed in stratospheric flight	Mach 2.3
Time-to-climb to 59,000 ft using auxiliary rocket engine and carrying guided missiles, from brake release	6 min 30 sec
Time-to-climb to 49,000 ft without auxiliary rocket engine, with guided missiles, from brake release	7 min
Take-off runway length with reheat, depending on take-off weight	2,000—4,000 ft
Take-off distance to clear 50-ft screen, with reheat, depending on take-off weight	2,800—4,300 ft
Landing run with brake 'chute	approx. 2,300 ft
without brake 'chute	approx. 4,100 ft
Landing distance over 50-ft screen	
with brake 'chute	approx. 2,950 ft
without brake 'chute	approx. 4,750 ft
Service ceiling	
without auxiliary rocket engine	59,000 ft
with auxiliary rocket engine	72,200 ft
Ballistic peak	
without auxiliary rocket engine	75,500 ft
with auxiliary rocket engine	95,100 ft
Approach turning radius, depending on all-up weight	1,500—3,300 ft

follows (data for the prototype are given in parentheses):

- A more powerful engine, the SNECMA *Atar 9* of 13,200 lb thrust with reheat *(Atar G* with 9,680 lb thrust);
- Wing area increased to approx. 375 sq.ft. (312 sq.ft.) with conical camber (no conical camber);
- Mean thickness/chord ratio reduced to 4 percent (5 percent);
- Variable geometry air intakes (fixed geometry);
- CSF *Cyrano* or Ferranti *Airpass II* fire control and bomb release system (not incorporated).

The first aircraft of the pre-production batch took off on its maiden flight on May 12th, 1958. At the 35th test flight Mach 2 was reached, and in a few months the *Mirage III's* entire performance range was tested up to altitudes of over 67,000 ft. The auxiliary rocket engine was used in over 60 flights. Flight tests are at present being conducted with the other pre-production aircraft.

The satisfaction of prospective buyers with the results of flight tests have found tangible expression in a letter of intent from the French Government for 400 aircraft, of which about a third have so far been ordered on a firm basis. Quantity production began at the end of 1958, and the first production aircraft are to be delivered in autumn this year. Development work is under way on a two-seat trainer version, whose prototype flew for the first time in November last year.

● Technical Description

AIRFRAME. The classical *sharply-swept delta wing* (leading edge sweep 60°) combines the advantages of low drag in the transonic speed range with high resistance to bending and torsion in the supersonic range. An incidental advantage is the considerable volume of wing available for fuel supplies and parts of the retractable undercarriage. Rivets and bolts attach the integrally milled skin to the three forged spars (leading edge, main and trailing edge). Each wing is fitted with 2 coupled *elevons* (combined elevators and ailerons) and a short inboard trimming *flap*. The air brakes are fitted between the leading edge and main spars. Box-type main connections at each main spar and three further connections at the leading edge and trailing edge spars join the two half-wings to the fuselage. This enables a damaged wing to be replaced *en bloc* for rapid repair purposes. In addition, the *Mirage III* can be transported dismantled on a low-loading truck of normal size, without any part of the load exceeding the international maximum dimensions for first-class roads (2.50 × 3.80 m = 8 ft 3 in. × 12 ft 6 in.). These advantages undoubtedly compensate for the additional cost of construction.

The *fuselage* has a removable nose containing the CSF *Cyrano* or the advanced Ferranti *Airpass* fire control and bomb release system. Behind is the pressurized, insulated cockpit, beneath which is installed the Bendix doppler radar antenna, if used. The next section of the fuselage contains the nosewheel bay and a compartment for interchangeable equip-

The most modern tooling at GAMD's Argenteuil works enables large numbers of aircraft to be produced economically. On this ONSRUD special milling machine large wing skin panels are milled from the block form.

ment packs; at its sides are the air intakes with their variable central cones. In the central section of the fuselage are fuel tanks, main undercarriage bays, a second compartment for equipment packs and all the auxiliary units with their gears. Next comes the central portion of the wing, and finally, the tail section with the main powerplant and the optional rocket engine. The brake 'chute is inside the removable tail skin.

The tail fin consists of three spars plus the skin, which forms a torsion box from the leading edge to the trailing edge spar. At the back is the *rudder,* while the leading edge, constructed of plastic reinforced with fibreglass, contains the UHF aerial.

The conventional *tricycle undercarriage* is hydraulically retracted into the fuselage, the main undercarriage wheels sideways, the nosewheel backwards. When the undercarriage is fully extended, the doors of the main bay are closed again. Low-pressure tyres (approx. 114 p.s.i. for the main wheels, 85 p.s.i. for the nosewheel) enable the aircraft to take off and land on semi-prepared strips—even on hard turf—and make it to a great extent independent of concrete runways. The pilot actuates the brake by pedals, and there is a hand brake for emergency use. The brake 'chute is also operated mechanically by the pilot.

POWERPLANT. The core of the *Mirage III C* is the *SNECMA Atar 9C reheat jet engine.* The combustion air enters through two air intakes whose geometry varies automatically with the Mach number, and passes to the nine-stage axial compressor, where it is compressed to 5.5 times atmospheric pressure and heated in an annular combustion chamber. A two-stage gas turbine drives the compressor and the auxiliary units (via gears). The normal engine speed is 8,400 r.p.m., but the *Atar 9C* can be overspeeded at Mach numbers above 1.4, increasing the maximum thrust by as much as 9 percent at Mach 2. At maximum thrust with full reheat the specific fuel consumption is barely more than 2 lb/lb/h, and is somewhat less than 1 lb/lb/h at cruising speed without reheat. Further data are as follows: thrust/frontal area ratio 1,800 lb/sq.ft.; power/weight ratio 4.79 lb/lb; sea level thrust without reheat 9,370 lb, with reheat 13,200 lb. The pilot has only one control to operate; r.p.m. and gas temperature are automatically regulated as the fuel feed and jet pipe cross-section are altered. The engine is started by compressed air.

Special stress is laid on simplicity of engine installation. After removal of the fuselage tail skin, which is fixed at four points, the engine pylon, also fixed at four points, is loosened and the engine is slid out from the back along

Pre-production model of the Mirage III C *with navigation and fire control radar fitted... CSF Cyrano or Ferranti* Airpass II? *Beneath the fuselage is an air-to-air guided missile, apparently an advanced model of the Matra 511.*

Ferranti Airpass II and CSF Cyrano

Lightweight Navigation and Fire Control Systems

A chain is as strong as its weakest link . . . efficient arms and high performance aircraft form a hard-hitting weapons system only if they can be operated at any hour of the day or night—and in any weather—with the same degree of reliability. For military operations in the area near the front line it is decisively important to be able to bring one's forces into contact with the enemy not only with a high measure of certainty but also without delay.

A largely automatic navigation and fire control equipment therefore forms an integral component of the *Mirage III C* weapons system. This aircraft now offers a choice between the *Cyrano* equipment, manufactured by Compagnie Générale de Télégraphie sans Fil (CSF), and the Ferranti *Airpass Mk.II.*

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Airpass II is an advanced model of the *Airpass I,* which is already in production for the Royal Air Force, and meets the latest requirements put forward by NATO.

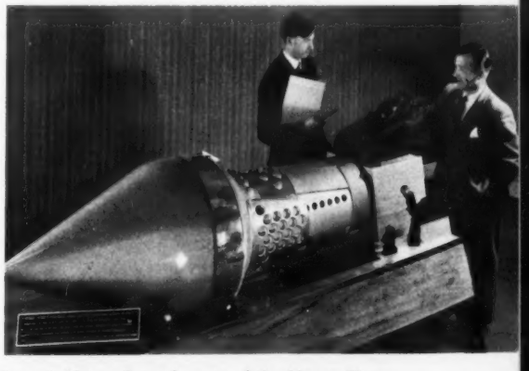
Ignoring the switches and indicators in the cockpit, *Airpass II* constitutes a self-contained, rapidly interchangeable unit mounted in the fuselage nose. The computers, required only for fighter-bomber missions, can be installed in a separate exchangeable slide-in rack, so that no modifications need be made to the nose unit. The same reportedly applies to the *Cyrano* system.

• Interception and airspace patrolling

Initially the radar works in the "search mode"; i. e., the antenna array, stabilized in roll and pitch, scans in an elevation and azimuth selected by the pilot. Once an air target has been picked up on the screen, the antenna group automatically locks on to the target, with the aid of a computer. This process can also be initiated, of course, if a target is detected visually. The fire control system computes the optimum approach path, either on a lead course or on a pursuit course. The sighting head then displays not only steering instructions for the pilot, but also details of the closing speed, firing bracket and aircraft attitude.

• Bombing

The pitch and roll stabilized antenna works in the "mapping mode." The screen displays the terrain ahead in plan position. Once the target—or other reference point—has been identified and tracked by the pilot, the computer system calculates the approach path and displays appropriate steering instructions on the sighting head. Here precise maintenance of the required course is essential. For *prepared* attacks (with accurately known reference point) bombing can be by the long toss or high toss method, for *unprepared* attacks with ground visibility by the "over-the-shoulder" method. In the latter case the pilot pushes a button to switch on the bombing computer as he flies over the target and then follows the steering instructions appearing on the sighting head.



Ferranti Airpass I, *predecessor of the* Airpass II, *as installed in the English Electric P.1B* Lightning *as a pure interception fire control system.*

• Attacking ground targets with guns or rockets

In good visibility the radar can be used for target sighting and ranging, with corrections for wind and aircraft speed being fed into the computer either from the doppler equipment or in the form of estimated values. In instrument conditions the only targets which can be attacked are those which return a clear radar echo, such as ships.

• Terrain avoidance at low altitude

Underflying the enemy's radar offers not only protection from enemy air defence forces but also the advantage of surprise. If the target approach takes place over hilly ground, the radar antenna is horizontally stabilized and scans the airspace ahead of the aircraft for obstructions. The radar screen then shows any rising ground in front of the aircraft or to either side of the course, so that the pilot can manoeuvre himself through the obstruction-free areas without danger.

two rails. Two large doors in the main undercarriage bay ensure ease of access.

The air intakes are set clear of the fuselage, so that the boundary layer generated on the latter's surface does not interfere with the intake of air. Part of the boundary layer is used to ventilate the engine compartment. No fireproof bulkhead has been provided.

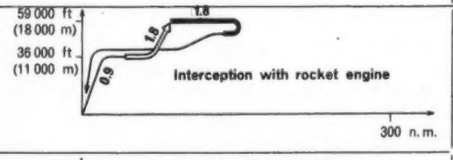
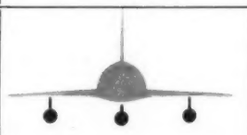
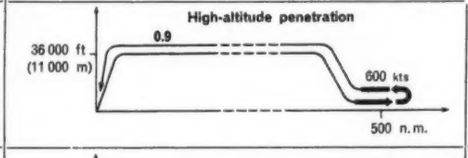
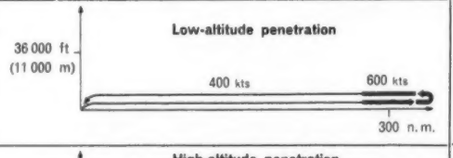
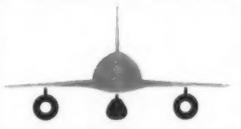
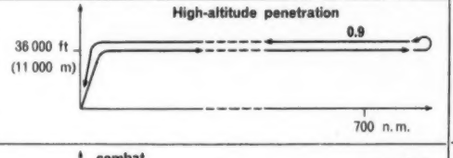
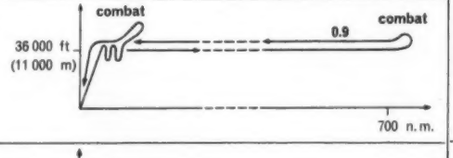
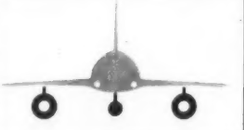
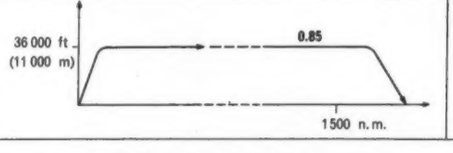
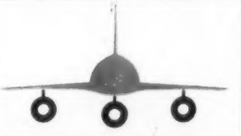
The fuel system is symmetrical and comprises two main groups of tanks, each consisting of two tanks in the fuselage and one wing tank. An additional small tank has been incorporated behind the pilot's seat to supply fuel in negative G conditions, e.g., in inverted flying. For missions where the rocket engine is not used it is also possible to fit various combinations of tanks in the front and rear equipment compartment and under the aircraft. The groups of tanks are interconnected by a cross-feed system, but the fuel gauge indicates only the contents of the fuselage tanks.

An *SEPR 841 liquid-propellant rocket engine* can be mounted in the rear equipment compartment under the main engine, to serve as an auxiliary powerplant for interception missions. The fuel is a mixture of triethylamine and xylidine, the oxidizer nitric acid; the static thrust can be either 3,300 lb or 1,650 lb. Total propellant consumption is 16.5 lb/sec at 3,300 lb or 9 lb/sec at 1,650 lb thrust, the burning duration being 80 sec at full thrust. Starter, regulators and all safety mechanisms are fully automatic. The oxidizer tank, with a capacity of 79.3 U.S. gallons, or 1,005 lb of nitric acid, has a stressed skin. The front of the tank contains the pumps and auxiliary mechanisms, such as the oxidizer tank pressurization system, and forms, together with the combustion chamber and the propellant feed system, a self-contained unit which can be safely jettisoned at low flight speeds. The oxidizer tank is fitted with a flask of compressed air for pressurization. A jettison valve is also provided. The pumps are driven from the gear-box via a telescopic shaft, which is retracted when the rocket engine is jettisoned. The fuel tank has a capacity of 40 U.S. gallons, or 280 lb of triethylamine and xylidine, but is housed in a special "interception" pack. It is ventilated by air bled off from the main engine.

Flying Controls. The controls are in the form of a conventional control column and foot pedals. The control column movements are transmitted mechanically to the servo amplifiers, where a special device known as *Amédée* reduces any sensitivity in the neutral position. Electrically controlled servo pistons compensate for frictional loads. Each of the elevons is operated by duplicated servo controls connected to the two entirely separate hydraulic circuits. This guarantees maximum operational reliability. Differential control is provided.

The movements of the rudder pedal are converted into electrical pulses, which control a double electro-hydraulic power amplifier with electronic yaw damping.

Typical missions for the Mirage III

Mission	Take-off weight (1,000 lb)	SEPR rocket engine	Fuel capacity: Internal tanks (U.S. gall.)	Fuel capacity: External tanks (U.S. gall.)	Mission Profile	Fuel tanks and armament	Front View	Electronic equipment
Interception	approx. 19.2	Used	580 (+1,320lb rocket propellant)	—		1 air-to-air guided missile with semi-active homig head, 2 air-to-air guided missiles with infra-red homing head, internal auxiliary tanks for kerosene or rocket engine.		TACAN, PHI Navigation and fire control radar (*Cyrano* or *Airpass II*)
	approx. 18.1	Not used	685	—				
Ground support	approx. 24.3	Not used	765	500		2×30-mm cannon, various combinations of rocket launcher/ fuel tanks, chemical and nuclear bombs, guided missiles, heavy rockets and napalm bombs.		TACAN, PHI Navigation and fire control radar as above
Long-range attacks on ground targets	approx. 24.3	Not used	740	685+		Chemical and nuclear bombs, air-to-surface guided missiles, jettisonable fuel tanks.		TACAN, PHI Navigation and fire control radar as above Doppler radar (optional)
Photographic reconnaissance	approx. 23.2	Not used	740	685+		Photographic equipment, consisting of vertical and oblique cameras for high- or low-altitude flying, photo flashbombs, jettisonable fuel tanks.		TACAN, PHI
Airspace patrolling	approx. 23.8	Not used	685	685+		2×30-mm cannon, various combinations of rocket launcher/ fuel tanks, air-to-air guided missiles and jettisonable fuel tanks, according to mission.		TACAN, PHI Navigation and fire control radar Doppler radar (optional)
Ferrying	24.3+	Not used	740	900+		Internal and external fuel tanks.		—

Jet engine without afterburner

Jet engine with afterburner

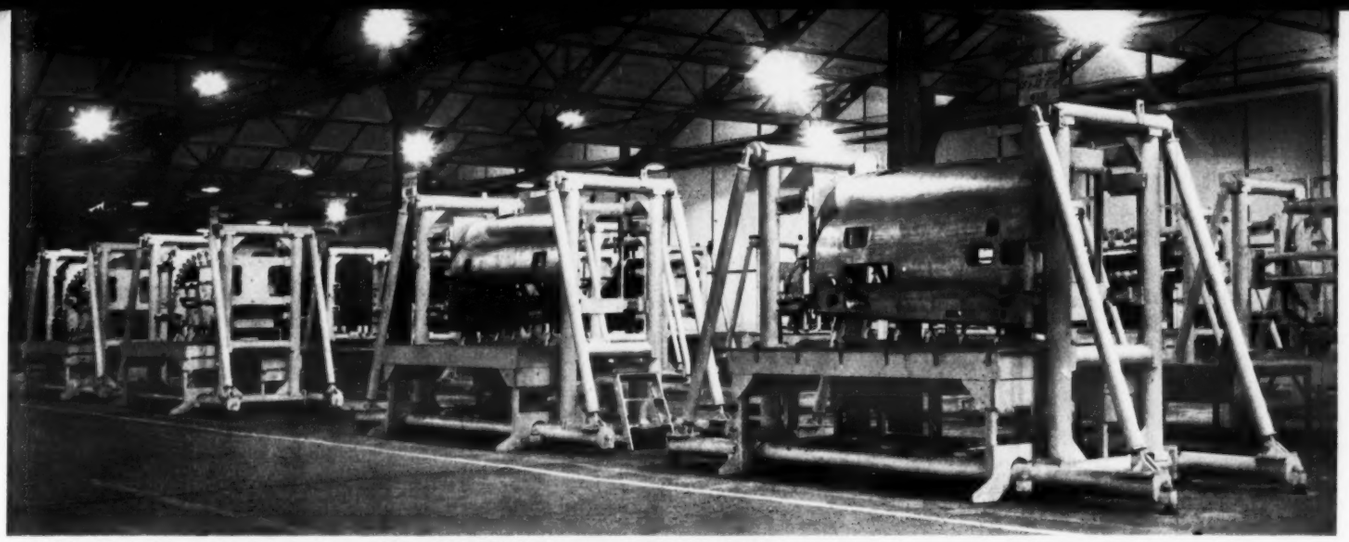
Jet engine with afterburner plus rocket engine

Air-to-air or air-to-surface missile

Fuel tank

Combined rocket launcher/fuel tank

Chemical or nuclear bomb



Assembling the fuselage. In the foreground are a right and left half-shell for the rear fuselage section.

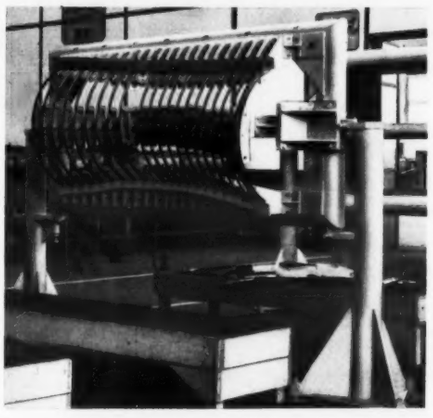
Air intake assembly jig.

The inboard trimming flaps are actuated automatically by electro-hydraulic servos, depending on the position of the control column. In addition, a pitch stabilizing gyro transmits corrections to the servos, which automatically damp pitch oscillations over the entire performance range.

Included in the standard equipment is an *autopilot,* which performs a variety of functions: elimination of control reversal, adjustment of stick forces to G loadings, maintenance of a constant flight altitude and/or Mach number, automatic roll and pitch stabilization by a sensing unit. The pilot can manually override the autopilot at any time.

HYDRAULIC SYSTEMS. Each of the two pumps driven by the *Atar's* gas turbines supplies an independent hydraulic circuit. *Circuit I* is also fitted with an electric pump for emergencies, which maintains power for the flying controls. Connected to this circuit are:

- the first set of servo units of the main controls (1 cylinder each);
- the undercarriage jacks for normal operation;
- the wheel and air brakes.



Jig for a fuselage transversal frame.

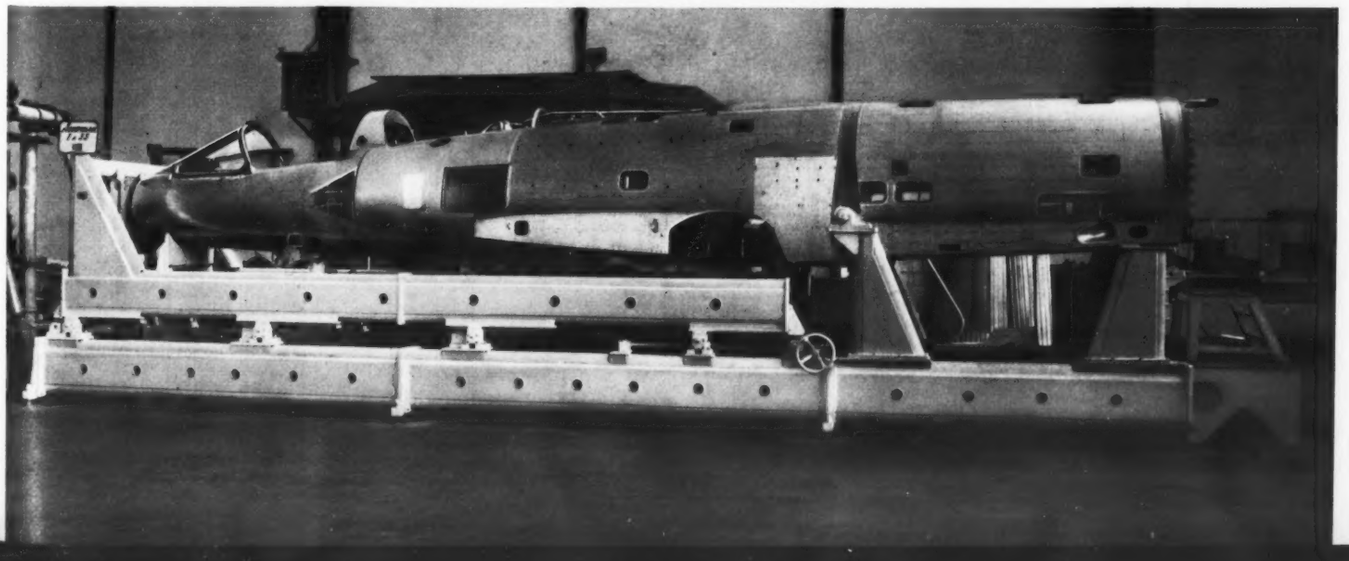
Circuit II (stand-by circuit) supplies:

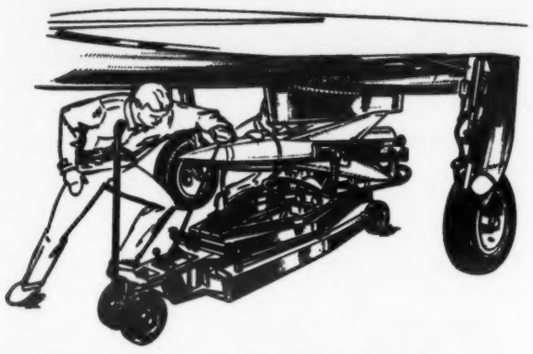
- the 2nd set of servo units of the main controls;
- the wing-flap servo controls;
- the undercarriage in an emergency.

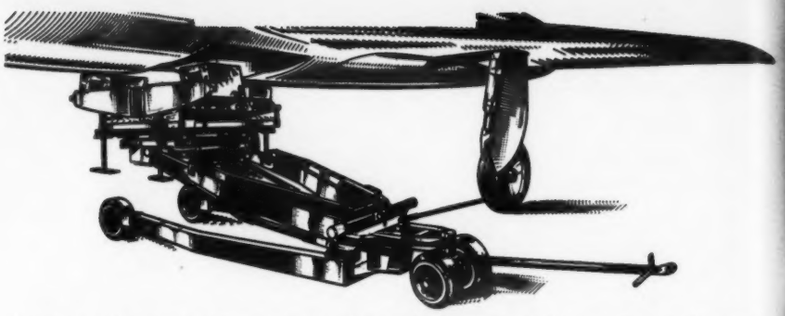
ELECTRICAL SYSTEMS. All vital installations are fed from a d.c. circuit; those requiring a.c. are fed via an inverter. If the d.c. generator (9 kW) breaks down, the a.c. generator (6 kVA, 400 c/s, 120/208 V) supplies the power for the entire aircraft via a transformer/rectifier. A battery is also available. Ground power supplies can be connected to the aircraft's a.c. and d.c. circuits.

PRESSURIZATION. Air is bled from two ports on the *Atar's* compressor. After the air is precooled, one lead is taken to the air conditioning system of the cockpit and G-suit and the pressure seal of the cockpit canopy; the second pressurizes the fuel system, the rocket engine fuel tank and the hydraulic accumulator. The air conditioning plant feeds warmed air into the cockpit either directly, for heating and window demisting, or indirectly, via intermediate coolers and vaporizers. The pilot selects the cockpit temperature he requires, and the air conditioning plant looks after the rest automatically. If the air flow drops as a result of reduction in engine speed, ram air can be used to demist the windshield.

Fuselage of a twin-seat *Mirage IIIB* after assembly, showing the wing attachments and the left main undercarriage bay.







Interchangeable packs for different missions make the *Mirage IIIC* a highly versatile tactical weapon, which can be rapidly rearmed to ensure maximum operational readiness. The hydraulic lifts can be operated by one man. *Left:* a guided missile being put in position. *Right:* the interception pack (rocket engine fuel tank and electronic equipment) being fitted.

SAFETY EQUIPMENT. A Martin-Baker Mk.4 ejection seat, which is normally operated by pulling down a curtain but can be actuated by a manual lever in the event of an emergency, enables the pilot to bale out even near the ground. The cockpit canopy is jettisoned by an automatic synchronization mechanism. The oxygen equipment feeds into the pilot's pressure helmet and suit at a rate which is automatically regulated as a function of altitude.

ELECTRONIC EQUIPMENT. The standard equipment comprises:

1 SARAM UHF RT installation;

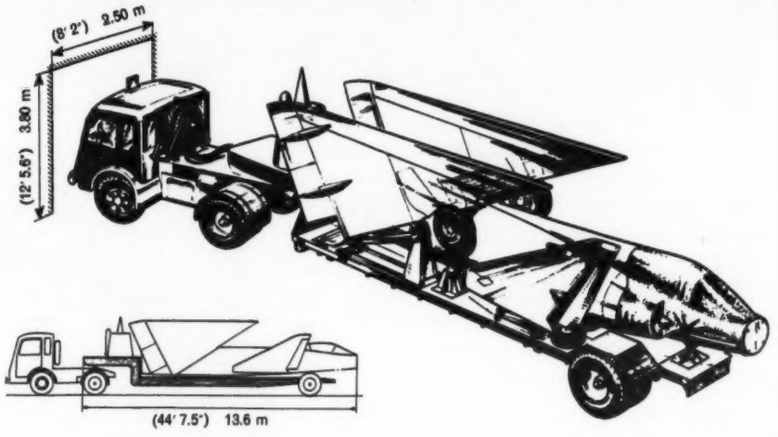
1 IFF equipment;

1 PHI or ANADAC dead reckoning system;

1 TACAN equipment;

1 CSF *Cyrano* or Ferranti *Airpass II* radar.

The equipment can be supplemented by a second SARAM UHF installation, a doppler radar, a UHF homing indicator and ECM equipment.



Mobility in the broadest sense is the primary requirement for a weapons system in the forward areas. When dismantled the *Mirage IIIC* can be loaded onto a semi-trailer of normal dimensions for movement on first-class roads.
The particular advantages of this method of transport are dispersal and mobility, even when the number of airfields is limited; protection against enemy attack—even with nuclear weapons—by stowing the aircraft far from airfields in small bunkers or tunnels cut in mountainsides; rapid transport of operational or reparable aircraft to undamaged bases or workshops after their own base has been destroyed.

ARMAMENT. To enable it to perform its wide variety of missions, the *Mirage IIIC* can carry many combinations of modern operational weapons: cannon, unguided missiles, chemical and nuclear bombs, air-to-air and air-to-surface guided missiles. With the aid of the improved Ferranti *Airpass Mk.II* fire control system, the *Mirage IIIC* is able to operate in all weathers. To take an example: with two 30-mm cannons, two containers of 36 rockets each and two bombs weighing about 1,000 lb, the *Mirage IIIC* can attack ground targets at up to 300 miles' range.

• Preparation for missions

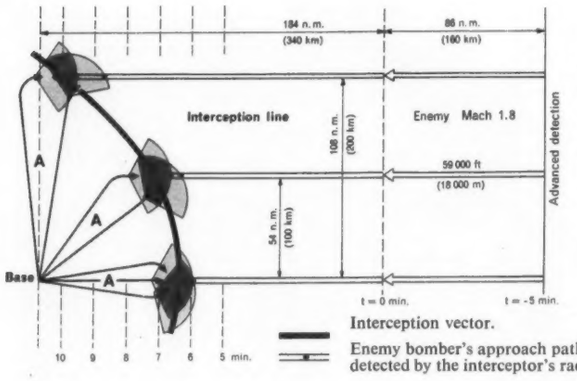
The high speeds of present-day offensive weapons systems require the maximum degree of operational readiness on the part of the defence. In the combat zone a defensive mission will have no chances of success unless it can get into the air immediately after the enemy has been detected and identified. The same applies to ground support and fighter-bomber missions. Moreover, special problems are involved in rearming a highly versatile aircraft such as the *Mirage III* between two entirely different types of mission.

Wherever operational bases are dispersed it is vital to combine maximum readiness with minimum expenditure of personnel and equipment, and a team of GAMD engineers devoted months of research to this requirement. The result of their studies is that, with equipment prepared in advance, the *Mirage IIIC* is ready for take-off and taxiing along the runway about 18 seconds after the alert. The maximum time needed for complete rearmament is less than one hour; and a bare two hours are required for changing the engine.

The ground support equipment consists basically of standard units which can be dismantled for transport by air. The accessibility of all vital parts of the aircraft and the possibility of replacing entire assemblies *en bloc* greatly facilitate rapid maintenance and repair.

*

From the production point of view the *Mirage IIIC*—apart from a few components—does not make excessive demands on manufacturers' tooling; only the wing, with its integral construction, has involved the purchase of some expensive special machinery. Consequently, licence production of the *Mirage IIIC* would be well within the capability of small countries without highly developed aircraft industries. ←



Distance-time diagram of an interception mission with lead course against an enemy bomber approaching at 59,000 ft at a speed of Mach 1.8. It is assumed that the enemy is identified at a distance of 270 n.m. from the base and the interceptor takes off 5 minutes later (t = 0 min). During these 5 minutes the enemy has covered another 86 n.m.; the interceptor's flight paths (marked A) are a function of the lateral distance of the bomber's approach path from the base. The diagram shows three separate cases: 0 n.m., 54 n.m., and 108 n.m.

Sunnyvale: a Study in Cooperation

Over the past four years a vast new complex of buildings covering 645 acres has been growing up at Sunnyvale, California, some 40 miles from San Francisco and close to Moffett Naval Air Station. These buildings house the major portion of Lockheed's Missiles and Space Division and, on an adjoining plot of land, the Air Force Satellite Test Center. Together they constitute the most extensive satellite centre in the United States—perhaps in the entire world—and furnish a telling example of how industry and armed services can work together in close cooperation in the furtherance of national objectives. Here Air Force and Lockheed controllers sit side by side in the satellite control room; here service and civilian personnel follow the results of their combined efforts with the same absorbing interest.

The Lockheed facilities

Headed by Vice President Herschel J. Brown, the Lockheed Missiles and Space Division is engaged on all aspects of design, production and flight of complete satellite systems, under contract to the USAF Ballistic Missile Division, on production of the *Polaris* submarine-launched missile for the Navy, and on research in almost every field of science. At present some 50 percent of the facilities are devoted to work on *Polaris*, 40 percent to satellites, and the remaining 10 percent to other projects.

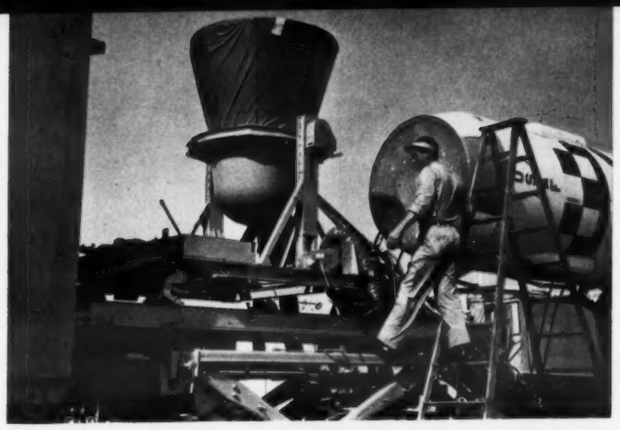
The *Polaris* is already too well known to readers of *Interavia* to require further description here. Suffice it to add that the programme is advancing in a highly satisfactory manner; of the ten launchings so far carried out with the current series of vehicles (close to the configuration of the tactical weapon), seven have been complete successes, and three partial successes. The *Polaris* is due to go into service with the Navy late this year.

Lockheed's Missiles and Space Division is the prime contractor and systems manager for the Air Force's WS-117L programme, which covers three separate projects: *Discoverer, Midas* and *Samos*. The *Discoverer* programme, under which ten launchings had been made by the end of February, 1960, is aimed at developing a working military satellite system; *Midas* (Missile Defense Alarm System) is designed to increase warning of hostile ballistic missiles; while *Samos* is a surveillance satellite project.

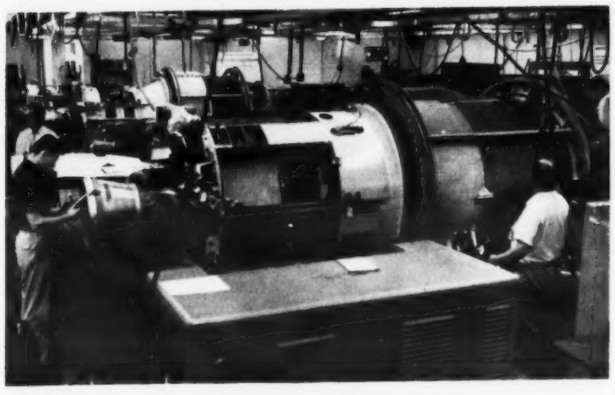
The basic satellite vehicle for all three projects is the *Agena*, for which Lockheed supplies the airframe, launching and tracking, and Bell the liquid-propellant engine. The only space vehicle at present in production on an assembly line basis, *Agena* is 19 ft long and 5 ft in diameter in its present configuration; weight is 8,500 lb on launch, 1,700 lb in orbit.

Typifying the close cooperation which exists between the Lockheed Missiles and Space Division and the U. S. Air Force: Group Vice President L. Eugene Root with Lt. Gen. Bernard A. Schriever, Commander, Air Research and Development Command, at the January inauguration of the Satellite Test Center.

The Lockheed Missiles and Space Division plant at Sunnyvale, California. 1. Satellite production building; 2. administration building; 3. Satellite Test Center (under command of the USAF Ballistic Missile Division, but run jointly with Lockheed); 4. support groups, plant engineering, machine shops; 5. office services, purchasing, laboratories; 6. Naval Industrial Ordnance plant (*Polaris* production). The Sunnyvale plant covers an area of 2,670,000 sq. ft. and employs 12,570 of the Division's total 19,600 personnel.

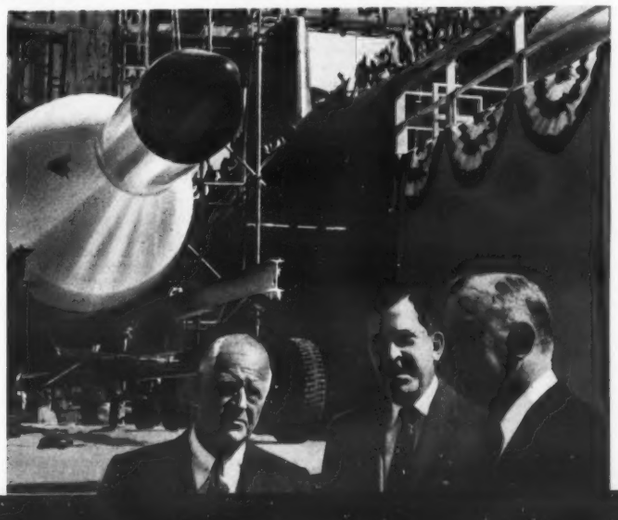


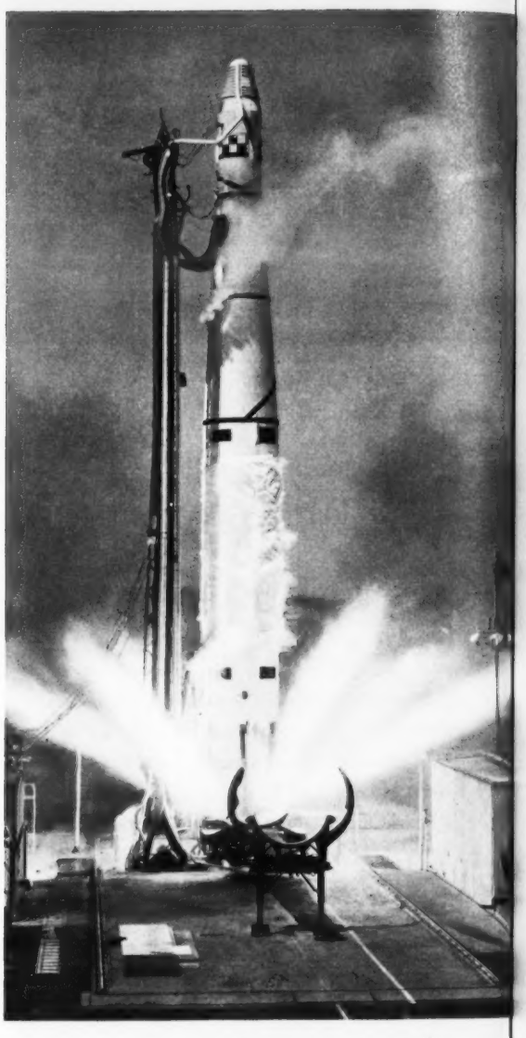
Above: Re-entry vehicle and recoverable capsule ready for mating with the *Thor/Agena* booster for a *Discoverer* launching. Ten *Discoverer* launchings had been made by the end of February, 1960, with varying degrees of success, though it has not yet been possible to recover the capsule as planned. New recovery methods are now under study. *Below:* The *Agena* undergoes final checkout at the Sunnyvale plant.



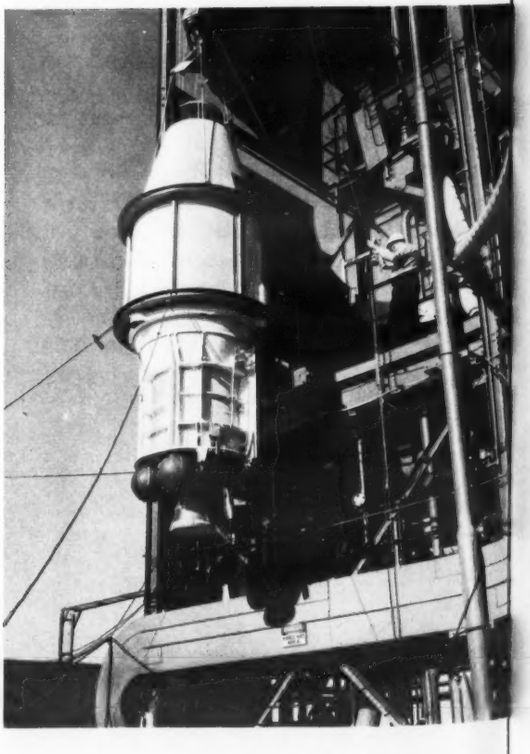
J. W. Plummer, *Discoverer* Program Manager; D. J. Murphy, Satellite Systems Assistant Manager; R. D. King, Satellite Systems Operation Manager; S. J. Marcus, Assistant to the *Samos* Program Manager; and J. J. Knopow, *Midas* Program Manager.

Lockheed Chairman Robert E. Gross with Frank J. Bednarz *(Polaris* Technical Director, Missiles and Space Division) and Daniel J. Haughton, Executive Vice President, at the launching of the *Polaris*-carrying *USS Theodore Roosevelt* submarine.



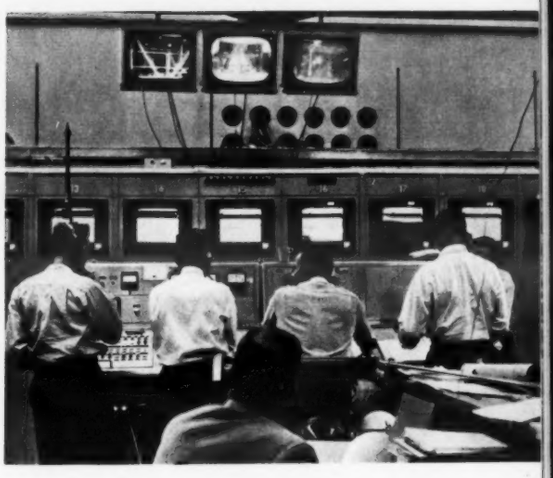


The complete *Discoverer* vehicle just before lift-off at Vandenberg.



The *Agena* satellite being hoisted into place for a test firing at Lockheed's Santa Cruz facility. All vehicles are rigorously tested here before going to Vandenberg AFB, California, for launching into space.

Satellite Control Room at the Sunnyvale Satellite Test Center, manned jointly by Air Force and Lockheed staff. Closed circuit television screens display teletype messages from the tracking stations and satellite position plotting boards.



In the *Polaris* blockhouse at Santa Cruz during final count-down for a test firing. Television monitors mounted above the consoles show critical phases of the firing, while rows of oscillographs and recorders prepare a complete report on the performance of subsystems and components.

Agena can be combined with a variety of boosters, depending on the programme for which it is to be used. In the *Discoverer* launchings, for example, it has been used in conjunction with a modified Douglas *Thor* IRBM as first stage and has shown a high degree of reliability. The full programme calls for the launching of about a dozen satellites to test the major systems and operations in preparation for the *Midas* and *Samos* projects, as well as for bio-medical and other scientific experiments. The latter include recovery of the payload capsule—an enterprise which has not yet been successful, despite satisfactory results in other phases of the operation.

A *Discoverer* launching takes place in broad outline as follows: the *Thor* lifts the vehicle to near-orbit altitude, then separates from the rest of the vehicle on burnout. Next the *Agena* coasts to orbit altitude and fires its own engine (15,000 lb of thrust) so as to reach the orbital velocity of nearly 18,000 m.p.h. Shortly after reaching orbit, the satellite turns through 180° to orbit tail first. Thanks to the Lockheed-designed inertial reference platform it carries, it is the first satellite vehicle which has been successfully stabilized in orbit—"a highly important accomplishment in the development of a system designed to perform warning, surveillance and communications functions," as Major General O.J. Ritland, Commander of the Air Force Ballistic Missile Command, put it.

In the *Midas* programme, *Agena* is used with a Convair *Atlas* ICBM as booster. The *Midas* satellite is designed to orbit several hundred miles above the earth, using infrared-sensitive instruments to detect enemy ICBMs immediately after launching. This will almost double the warning time available for counter-measures. The Air Force plans eventually to have at least six satellites in polar orbits for this task. A first experimental *Midas* launching was made at Cape Canaveral on February 26th, 1960, but the second stage failed to separate from the first, and no orbit was achieved.

The *Samos* surveillance satellite will also incorporate an *Atlas* as booster stage. So far, however, little or no information on this programme has been published.

Finally, the *Atlas-Agena B* combination, using the advanced, restartable Bell rocket engine, is expected to be ready by December this year. The new engine, with greatly increased tankage, will be capable of placing heavier payloads into higher orbits. NASA has proposed that this vehicle could be used for some of the space projects originally planned for the cancelled *Vega*, but so far Lockheed has received no contract for work of this kind. In particular, it is suggested, *Atlas-Agena B* could put a satellite into a stationary orbit 22,330 miles above the equator, as part of a global communications system.

The Air Force Satellite Test Center

The idea of establishing a satellite control centre at Sunnyvale alongside the Missiles and Space Division plant was originated by Lockheed, who donated the land to the Air Force. The Center, which was officially opened at the end of January, 1960, cover san area of 54,000 sq. ft. and though under Air Force command—the 6,594th Test Wing (Satellite)—is operated jointly with Lockheed's staff.

Despite the official name of Satellite Test Center, no actual testing of satellites is done here. Activities at present are confined to research and development, including checking of the behaviour of vehicles launched from Vandenberg AFB, California. The heart of the Center is the satellite control room, containing six consoles from which activities at the launch site and a number of tracking stations are directed. The Air Research and Development Command is enthusiastic about the results achieved at Sunnyvale and is planning to almost double the size of the installations there. A new control room adjacent to the present one is already being built, for example, to enable several satellites to be handled simultaneously.

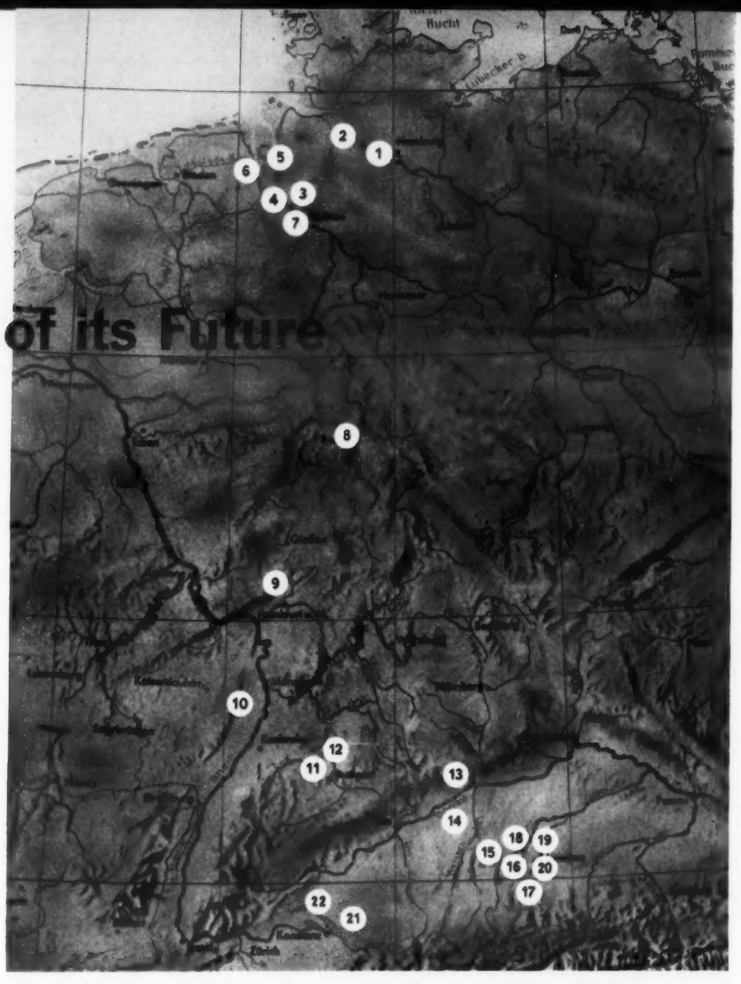
Center personnel now numbers 60, and the Air Force considers it as a permanent, long-term installation that could, at a later date, be moved up to operational status. ⟷

Before and after: Air Force officers and Lockheed executives watch tensely as last-minute reports come in on an *Agena* launching at Vandenberg (left). Right: Success! the satellite is in orbit, and everybody can relax. Obviously enjoying the moment is Willis Hawkins, Missiles and Space Division Assistant General Manager (seated, right).

An Industry in Search of its Future

West Germany's Aircraft and Engine Manufacturers

By K. Regelin, Interavia, Geneva



The major airframe and engine manufacturers in the German aircraft industry:

1 Hamburger Flugzeugbau GmbH, head office, airfield and main plant, Finkenwerder
2 Hamburger Flugzeugbau GmbH, Stade plant
3 Weser Flugzeugbau GmbH, head office, Bremen
4 Weser Flugzeugbau GmbH, plant and airfield, Lemwerder
5 Weser Flugzeugbau GmbH, Einswarden plant
6 Motorenwerk Varel GmbH, subsidiary of Weser Flugzeugbau
7 Focke-Wulf GmbH, Bremen airfield
8 Henschel Flugzeugwerke AG, Kassel
9 Klöckner-Humboldt-Deutz AG, Oberursel plant
10 Ernst Heinkel GmbH, Speyer
11 Ernst Heinkel AG, Stuttgart
12 Daimler-Benz AG, Stuttgart
13 Siebelwerke-ATG GmbH, Donauwörth
14 Messerschmitt AG, main plant and head office, Augsburg
15 Dornier-Werke GmbH, plant and airfield, Oberpfaffenhofen
16 Dornier-Werke GmbH, Munich-Neuaubing plant
17 Bölkow-Entwicklungen KG, head office and development laboratory, Ottobrunn
18 BMW Triebwerkbau GmbH, Munich-Allach
19 MAN Turbomotoren GmbH, Munich-Allach
20 Messerschmitt AG, final assembly plant, Munich-Riem airport
21 Dornier-Werke GmbH, head office and design office, Friedrichshafen
22 Bodenseewerk Perkin Elmer & Co. GmbH, Ueberlingen

While the world's major aircraft industries are having to face reorganizations or mergers and in almost all cases must tighten their belts, West Germany reveals a development which seems to run counter to this trend — at any rate at first glance. In a bare five years the Federal Republic's young airframe industry has grown to a labour force of roughly 13,000 persons. In addition there are more than 1,200 employees in the aircraft engine industry and 6,000 in the auxiliary industries allied to the aviation sector, not to mention an impressive corps of skilled workers in the electronic companies. The bigger companies can today show orders for the production, under licence or otherwise, of more than 950 military aircraft and for the maintenance and overhaul of no fewer than 2,570 aircraft. These will be joined during the next few years by some 670 F-104G supersonic single-seat combat aircraft, roughly 300 G.91 strike aircraft and a large number of new helicopters, so that the industry ultimately will be responsible for more than 3,500 aircraft for the Air Force. A task which—counting all the planned G.91 and F-104G production orders—will offer employment to a good 20,000 persons. It is therefore not surprising that the West German aircraft industry, aroused to new life after tedious preliminaries, should have attracted widespread interest, in view of this proud order backlog.

The writer recently had an opportunity to make an extensive study tour of Germany, during which he was able to acquaint himself with the problems and needs of the newest German industry and report on what has been achieved so far. Admittedly, the outcome of the visit still cannot provide a final answer to the question of where the industry is headed. If, however, an attempt has been made in the following paragraphs to underline the many difficulties encountered in reactivation and the results achieved by the various companies, this report should nevertheless be assessed merely as an interim account, as a record of a transition phase, which should lead to stronger participation of the German aircraft industry in the western world's overall production.

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To get a better judgment of the present state of affairs and of future prospects, we must first look back at the belated start of this industry in 1955.

When, after ten years' prohibition, Germany again received permission to build aircraft, in May 1955, it was clear for most of the companies that the only way to develop an adequate production capacity and to catch up with the progress made in the rest of the world was by building foreign designs under licence. At the same time — since the Federal Republic had been accepted into NATO as an equal partner—there began the build-up of the German Air Force. The initial stage of the industry thus coincided with the so-called *first phase* in the reactivation of the Air Force. It began with the cost-free supply of 450 American Republic F-84F fighter-bombers and 108 RF-84F reconnaissance aircraft under the Nash Agreement, with the gift of 75 Canadian *Sabre 5* day fighters and with the purchase of another 225 Canadian *Sabre 6s* and the acquisition of 88 F-86K all-weather fighters built by Fiat in Italy under North American licences. In addition, helicopters and trainers (T-6 and T-33) and numbers of British naval aircraft had to be included in the procurement programme. Needless to say, the 946 fighters and fighter-bombers purchased or received under the Nash Agreement, and the rest of the multi-type fleet had to be properly serviced and maintained. The training courses organized by the foreign manufacturers offered German technicians a welcome opportunity to acquaint themselves with the newer aircraft types. But is was not until licence contracts were placed for 112 *Noratlas* transports, 190 P.149 piston-engine trainers and 244 *Magister* jet trainers that the participating companies were able to get into their stride. Finally, Dornier received an order to produce 428 of the Do 27 which the company had developed in Spain and thus made the first German contribution to the Air Force's list of types.

During this first phase the following sums were made available for the procurement of aircraft and missiles:

1955	15 million DM
1956	400 million DM
1957	480 million DM
1958	938 million DM
1959	760 million DM

These figures do not, of course, include the aircraft supplied by the United States and Canada. For investments during the first phase a total of 35 million DM was made available to the industry out of the defence budget. The companies, however, used only 30 million and have meanwhile repaid this credit. To enable the industry to carry out the Air Force's maintenance

and overhaul programme, Mutual Security Aid funds totalling 16 million DM were provided. These figures as statistical supplement to Phase One.

Although an overall agreement had been made with the United States Government for the purchase of American war equipment in 1956 (Mutual Security Military Sales Agreement), the choice of the Federal Defence Ministry as regards licence-produced models for the first phase was limited to European types. But since, the same year, a German-American agreement on joint weapons development (Mutual Weapons Development Program) was initialled, and later an agreement on joint weapons production, it was to be expected that the Air Force would sponsor the licence production of American equipment for its *second build-up phase*. This second phase has the following objective: to take over weapons systems from Germany's NATO partners and adapt them to the technical and tactical requirements of the German Air Staff. Into this second phase, now in course, falls the licence production of American missiles such as the *Hawk* and the *Sidewinder* and the licence manufacture of the F-104G supersonic fighter-bomber. Within Phase Two, also, the G.91 NATO strike aircraft is to be built under licence and the Transall C.160 assault transport to be developed and produced (as a joint Franco-German project). In all of the above-mentioned types certain modifications were made, after careful weapons study by the Defence Ministry and the Air Force.

Under Defence Ministry plans, *Phase Three* of the German Air Force build-up will bring the supply of German weapons types, which will then be of entirely national design. These include, for example, the supersonic VTOL single-seat combat aircraft to be developed by the Entwicklungsring Süd (Southern Development Ring) as successor to the G.91. As the third phase also calls for a number of missile projects, the Air Force's build-up programme outlined here reveals itself as a welcome "pace-setter" for the industry, which—after overcoming initial difficulties and gaining experience through licence manufacture—would ultimately like to develop its own designs. Only in this way can it gather the experience and acquire the reserves without which it could not remain viable in the civil sector.

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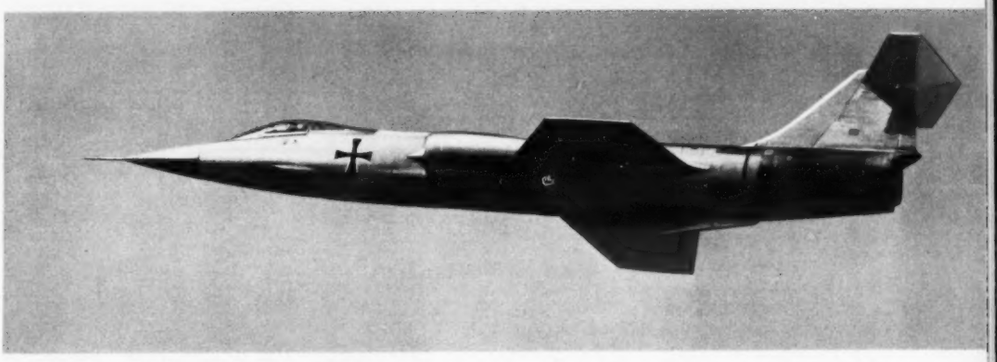
Is the Air Force's build-up programme with all its consequences capable of helping the young industry onto a sound basis, on which it—if only within a modest framework—can help influence the world market during the coming decades?

To get some idea of future possibilities, let us therefore once again review the bigger companies' manufacturing and development projects.



The Lockheed F-104, main weapon for the German Air Force during the second half of the sixties, is the biggest licence manufacturing programme yet undertaken by the German aircraft industry.

Airframe industry

Dornier-Werke GmbH, at Munich-Neuaubing (1,600 workers), was the first company since the war which was able to begin large-scale production of an original design. No fewer than 428 Do 27 STOL aircraft were ordered by the Federal Defence Ministry for the German Army, and 85 percent of these have already been delivered. Recently Dornier laid down another batch of 60 aircraft, most of them for export. Parallel to the production of the Do 27, an initial batch of ten Do 28 STOL transports (with two 250 h.p. Lycoming 0-540-A1A engines) is being built. Testing of the first two Do 29 experimental STOL aircraft with tilting propeller shafts for the pusher propellers is continuing; a third Do 29 prototype is under construction.

When production of the Do 27 for the armed services runs out this summer, the main plant at Munich-Neuaubing will begin licence production of fuselage centre sections and tailplanes for the G.91. Tooling is also in progress for the fuselage rear section of the Breguet 1150 *Atlantic* NATO naval reconnaissance aircraft.

Head offices and design office are located at Friedrichshafen, while the Dornier plant at Oberpfaffenhofen is responsible for overhaul and maintenance of 88 Fiat F-86Ks and 300 Canadair *Sabre 5/6s* for the Air Force. Here too the Fiat G.91s are to be finally assembled and test flown. Under an agreement with Vertol, Dornier has also become representative in Germany for this American helicopter manufacturer and undertakes maintenance of the Bundeswehr's 16 Vertol H-21s.

Of late Dornier has been giving more attention to the overseas market for the Do 27, in particular the South American market. In view of the chronic shortage of hard currency in the countries of this continent, an agreement for production under licence appears to be more promising than direct sales. It is no secret that the design office at Friedrichshafen is working on a smaller STOL multi-purpose transport (payload 3,300 lb) in which certain private operators are showing interest. Since Dornier was working some considerable time ago on a project with the designation Do P. 333/48, this transport (now known as the Do 31?) should not be much longer in appearing. Apparently it is a cantilever high-wing model with two 1,000 h.p. propeller turbines; take-off weight is around 17,000 lb, and take-off distance a little over 900 ft. Although Dornier is still interested in flying boats, the above-mentioned work, together with preparations for G.91 and F-104 licence production and other military development projects, can be expected to absorb the whole of the company's present capacity.

Focke-Wulf GmbH (1,000 workers) is producing, at its plant on Bremen airport, 190 Piaggio P.149D piston-engine trainers, 70 percent of which have already been delivered. In addition Focke-Wulf is responsible for maintenance and overhaul of 16 *Gannet Mk. 4/5s*, 68 *Sea Hawks* and 5 *Albatross* for the German Navy. Parallel to the aircraft work, Bremen is also engaged on civil production, which employs about one third of the personnel. This manufacturing programme covers hydraulic work platforms of all kinds, fuel tanks for marine craft, light metal and wooden superstructures for ships, etc. Future plans of the company, which belongs to the Standard Elektrik-Lorenz group, point in the most varied directions: the company's design office under Dipl.-Ing. G. Eggers (formerly with SNECMA) is working on a VTOL project outside the Entwicklungsring Süd. In addition, a relatively small share in the F-104G licence production by the Arbeitsgemeinschaft 104 (Nord-Gruppe) and inclusion in the Transall programme are also planned. Finally, Focke-Wulf is interested in missile production and hopes, for example, to be included in the *Hawk* programme. A study group from the company recently saw a demonstration of the British *Seacat* surface-to-air missile during a visit to Short Brothers & Harland.

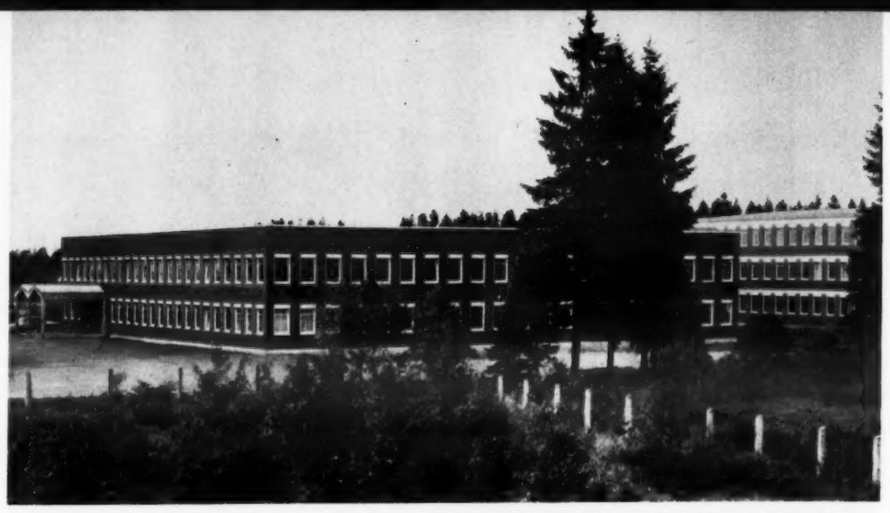
Hamburger Flugzeugbau GmbH—aviation section of the Blohm & Voss company, with more than 1,700 workers—is building fuselages for the *Noratlas* at both its main plant at Finkenwerder on the Elbe and the secondary plant at Stade. Finkenwerder also is responsible for final assembly and test flying of this twin-piston-engine transport. The 112 *Noratlas* covered by the Bundeswehr's first contract were manufactured here in an average time of 15 to 18 months per aircraft. Meanwhile, a second order for 17 additional *Noratlas* has been received, and these are now being delivered. The most important production plan for the coming years is the *Transall C.160* assault transport, which is being developed jointly by Nord-Aviation, Hamburger Flugzeugbau, Weser Flugzeugbau and Blume Leichtbau. As, however, quantity pro-

The Transall C.160 assault transport will go into production in two to three years' time as a joint Franco-German project. The first prototype is expected to begin test flying in mid-1962.

duction of the C.160 cannot be expected to begin before 1962/63, the company's production capability is to be utilized on manufacture of F-104G sub-assemblies as partner in the Arge 104 (Nord-Gruppe).

Under a contest organized by the Federal Ministry of Economics, Hamburger Flugzeugbau had worked out a project for a twin-engine medium-haul jet airliner (designation HFB 314), whose future, however, appears to be uncertain. A detailed description of this design, which uses two Rolls-Royce RB.141 jets, is printed elsewhere in this issue. Finally, Hamburger Flugzeugbau is engaged on the maintenance of all 145 *Noratlas* transports (including the 16 purchased direct from France).

Ernst Heinkel Flugzeugbau GmbH (over 1,000 workers) is building wings, tails and noses for the *Magister* jet trainer—on behalf of the Flugzeugunion Süd GmbH—in the Speyer plant which it occupied a few years ago. For the G.91 programme Heinkel is to supply the wings and main undercarriage. As partner in Arge 104 (Süd-Gruppe) the company will produce wings and tails for the F-104G. Tooling for the G.91 wing is in progress, and production is expected to begin this summer. Heinkel has also detailed more than 100 project engineers and designers to the so-called Entwicklungsring Süd; these men are working with engineering teams from Messerschmitt and Bölkow in the Deutsche Museum, Munich, on the project for a supersonic single-seat VTOL combat aircraft for the German Air Force. This aircraft project and the HE 211 short-haul airliner designed by Heinkel will be discussed later.



Part of the administration building and the design and development office at Bölkow-Entwicklungen KG, Ottobrunn, near Munich.

The *Kolibri I* (with 260 h.p. Lycoming VO-435-A1B engine), the first German post-war helicopter, was developed by Professor Focke at Borgward GmbH, Bremen.

A Dornier export hope: the Do 28 four-to-six-seat touring aircraft (now with two 250 h.p. Lycoming 0-540-A1As).

The Do 29 twin-engine STOL research aircraft with 275 h.p. Lycoming engines and downward tilting propeller shafts. The cockpit of this unusual prototype is equipped with Martin-Baker ejection seats.

Ernst Heinkel AG, of Stuttgart-Zuffenhausen, concentrates on the production of motor scooters and small cars. Its only aviation activity is overhaul of *Marboré II* jets (for the *Magister*) and of *Palouste* turbines (for the *Djinn* helicopter).

Messerschmitt AG (approx. 1,600 workers) is manufacturing *Magister* fuselages at its Augsburg plant; a branch factory at Munich-Riem airport handles final assembly and test flying of the *Magister*. As fuselage production at the Augsburg plant will run out at the latest by January or February 1961 (*Magister* final assembly at Munich-Riem is due to be completed by about April next year), efforts are being made to get G.91 licence production started as soon as possible. Messerschmitt will supply the fuselage nose and the fuselage rear for the NATO strike fighter. Quantity production of the F-104G will probably begin in the spring of 1961. At Munich-Riem the company also overhauls the Air Force's 110 T-33 jet trainers. Like Heinkel, Messerschmitt also maintains a fair-sized development group, which is working on the already-mentioned VTOL single-seat combat aircraft in the Entwicklungsring Süd in Munich. Nothing is known at the present time about civil projects from Messerschmitt AG. However, the company hopes, with the backing of the Defence Ministry, to be able to build a four-seat version of the *Magister* as a communications aircraft, which might also be considered for civil use.

Siebelwerke-ATG GmbH, with offices and plant at Donauwörth, is a member of the Flugzeugbau Nord group and is working on the *Noratlas* programme, producing fins, tailplanes and outer wings for this transport. Within Arge 104 (Süd-Gruppe) Siebel will produce the F-104G's fuselage rear. The company is reported to be working on a small sports and touring aircraft, and it is not beyond the bounds of possibility that Siebel, together with other German firms, will take part in the contest for a small training and sports aircraft which the Federal Ministry of Economics is expected to announce shortly.

Weser Flugzeugbau GmbH. With nearly 4,000 workers and two large factories in Lemwerder and Einswarden, this company (head offices in Bremen) is the biggest single enterprise in the German aircraft industry; major shareholders are Krupp (majority holding) and United Aircraft Corp. (43 percent holding). Weser undertook the decocooning of the 215 F-84Fs brought to Germany by aircraft carrier, the basic overhaul of 165 F-84Fs handed over to Germany after service with the USAF in Europe and partial overhauls of additional aircraft of this type ferried over from the United States. Altogether Weser has 558 aircraft of the F-84F and RF-84F types under its care at the Lemwerder plant. Under an agreement between Weser and the Defence Ministry, the funds earmarked for storing all F-84s and getting them into service run into some 40 million DM. The Einswarden and Lemwerder plants are manufacturing parts of the wing centre section, the tail booms and the engine nacelles for the *Noratlas*, which after assembly at Einswarden are sent to Hamburger Flugzeugbau at Finkenwerder for mating with the rest of the aircraft. Near Varel, Weser has engineering shops with highly modern equipment, where jigs for aircraft construction, tools and machine tools are produced.

The Bölkow 810 *Cobra* wire-guided anti-tank rocket is being produced in large numbers for the German armed services. The U.S. Marine Corps has already tested this weapon, and the British Army is also reported to be showing interest.

The company's close collaboration with the Sikorsky Division of United Aircraft suggests that Weser Flugzeugbau GmbH plans to turn to helicopter construction at a later date. A good-sized development team from Weser is permanently attached to Sikorsky at East Hartford, Connecticut, and it is reported that this company is working with Sikorsky on a large crane helicopter and various other helicopter designs. The most important aircraft project is the *Transall C.160* assault transport. Weser is now main contractor for the whole C.160 programme and will therefore be responsible for coordinating the projected production of the assault transport. If Weser is embarking on the erection of a new project and design office in Lemwerder, developing an executive aircraft, engaged in the construction of the prototypes of the DFS-582 jet-powered high-altitude research sailplane and working on numerous other projects on the side, this testifies to the Bremen company's dynamism. As a forward-looking enterprise with adequate production and development capacity, Weser should in all probability continue to play a leading role in the German aircraft industry during the years to come.

Bölkow-Entwicklungen KG (approx. 1,000 workers), at Ottobrunn, near Munich, occupies a special position among the companies in the German airframe industry, and for this reason has been left to the end of

the present survey. Active in nearly all the fields of aviation, Bölkow undertakes numerous investigations—under contract to the Federal Defence Ministry—on missiles which may well have a decisive influence on Germany's future weapons development. Several hundred scientists, project engineers and designers are working in a large building in Ottobrunn (provided by the Federal Government) in the field of anti-tank rockets, tactical surface-to-surface weapons for short and medium range, surface-to-air missiles and air-to-air weapons. Another group of engineers is working within the Entwicklungsring Süd on the armament and electronic equipment for the planned German VTOL single-seat combat aircraft. The company is also engaged on plans for a VTOL aircraft using ducted fans. Still other engineer groups deal with questions of guidance and control. Near Ottobrunn Bölkow has a number of rocket test stands for small solid-propellant motors, and at Schrobenhausen, near Augsburg, rocket motors are manufactured and filled—on the premises of a former ammunition factory.

Flugzeugbau Nord GmbH (Hamburger Flugzeugbau, Siebel-Werke ATG and Weser Flugzeugbau) has produced more than a hundred *Noratlas* transports (two SNECMA *Hercules 759s*) under licence.

Armstrong Whitworth-produced *Sea Hawks* are used by the German Navy as fighter-bombers and long-range reconnaissance aircraft with special radar equipment.

German Air Force Canadair *Sabre* 6 day fighter with fully automatic Martin-Baker ejection seats.

German Air Force F-84Fs are prepared for flight testing after basic overhaul at Weser Flugzeugbau's Lemwerder plant.

After completing the design of the Bö 102 *Heli-Trainer* (for the German Army), Bölkow developed this equipment into the Bö 103 one-man helicopter with a gross weight of 880 lb. Advanced development of the so-called Derschmidt rotor for high-speed helicopters is being pursued energetically, with Federal Defence Ministry funds. This split blade rotor promises to give a medium-size helicopter (for some four to six persons) considerably higher cruising speeds than a conventional rotor. Finally, Bölkow is participating in the Federal Defence Ministry's contest for a crane helicopter. On the company's civil sales list are the two-seat Klemm 107C (46,500 DM with basic equipment), the French *Fauvel* AV-36 tailless sailplane with auxiliary engine and the Bölkow FS-24 *Phönix* high-performance glider of plastic and balsa wood. Bölkow also owns the firm of Apparatebau Nabern GmbH, located to the south of Stuttgart, where a plant with nearly 300 skilled workers is producing civil aircraft as well as parts of the *Cobra* anti-tank missile. The surprisingly rapid expansion of the Munich plant is expected to continue during the next few years; the installation of a Siemens 2002 electronic computer shows that "development" still plays a vital role at Bölkow.

Engine industry

BMW Triebwerkbau GmbH, of Munich-Allach, is a subsidiary of Bayerische Motorenwerke AG but—since the parent company fell into financial difficulties some years ago—has been made largely independent with the support of the Province of Bavaria and the Federal Government. The facilities at Munich-Allach survived the war almost undamaged and were able to begin some years ago on the overhaul of Continental tank engines for the U.S. forces, with licence production of Lycoming GO-480-B1A piston engines for the Piaggio P.149 and the Dornier Do 27 and finally even to proceed to the development of an original small gas turbine (Type 6002) for a shaft power of 65 h.p. Meanwhile the company has been entrusted with the overhaul of *Orenda* jets for the German Air Force's F-86s, so that total employment has now reached more than 1,100 persons. A separate study group has developed a small by-pass jet in the 550—770 lb power class for VTOL aircraft, whose future is not yet settled. The 6002 gas turbine has since been converted into a jet engine for 77 to 88 lb thrust, which with a weight of slightly over 77 lb could be installed in sailplanes (designation 8011).

In the production sector, BMW will continue with licence manufacture of the Lycoming engine for the time being and deliver roughly 25 engines a month. Later, licence production of the J79 jet for the F-104G is due to begin. Although Belgium's Fabrique Nationale d'Armes de Guerre is also to be included in the European J79 licence programme, BMW expects to

Dornier Do 27 STOL aircraft (275 h.p. BMW Lycoming GO-480-BIA6).

Piaggio P.149 trainer (Lycoming GO-480-BIA6) built under licence by Focke-Wulf at Bremen.

A *Magister* jet trainer supplied by Flugzeugunion Süd ready to be ferried to its unit.

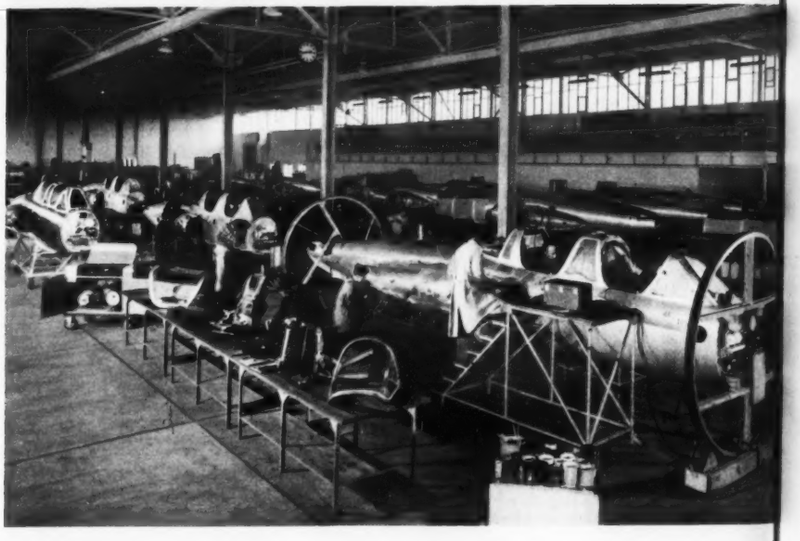
Final assembly and test flying of the *Magister* are carried out at Munich-Riem airfield, where Messerschmitt AG has a large assembly shed and the necessary flight testing facilities.

Tour of the German

In a bare five years the German aircraft industry has succeeded, despite very modest beginnings, in reaching full employment and in providing firm jobs for 13,000 persons in the airframe sector alone. The significance of this upsurge can be appreciated when it is remembered that after the war most of the companies were obliged to embark on the production of household articles or semi-finished parts for other industries in order to keep alive. Many of them have meanwhile found a flourishing market for their non-aeronautical products and are continuing in these lines, but today the picture is clearly dominated by the

Fabricating the *Magister* wing at Heinkel Flugzeugbau's Speyer plant.

Assembling the *Magister* fuselage at Messerschmitt AG, Augsburg.

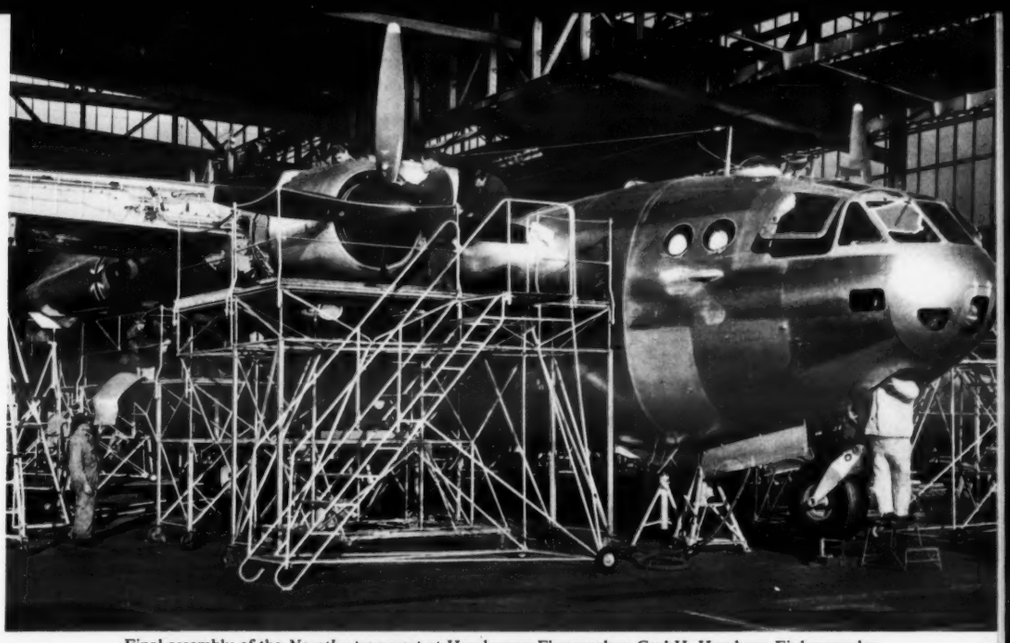


Inside the final assembly shop at Focke-Wulf, Bremen, where more than 130 P.149 piston-engine trainers have already been assembled. In the foreground, a German Navy *Sea Hawk* which has come in for overhaul.

Final assembly of the Dornier Do 27 at Dornier's Neuaubing plant. A small batch of the Do 28 twinengine touring aircraft will shortly be built here, now that the majority of the Do 27s ordered by the armed services have been delivered.

Aircraft Factories

production of newer aircraft types. With the support of the Ministries of Defence and Economics and thanks to considerable individual efforts, modern tools and machinery have been procured, with the aid of which the first licence manufacturing programmes for the Air Force and the Army have been pursued on schedule. When production of the models shown here is phased out, some of the workshops will remain empty for a time, although the companies are already preparing for the manufacture of approaching 1,000 single-seat combat aircraft of the G.91 and F-104G types.



Final assembly of the *Noratlas* transport at Hamburger Flugzeugbau GmbH, Hamburg-Finkenwerder.

Noratlas fuselages awaiting mating to wings, tail booms and tail units, which are supplied by Weser Flugzeugbau and Siebel ATG.

Assembly of tail booms for the *Noratlas* at Weser Flugzeugbau, Einswarden.

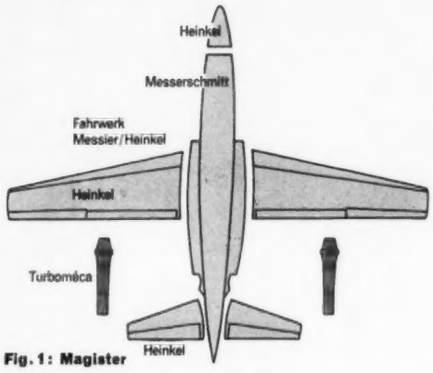


Fig. 1: Magister

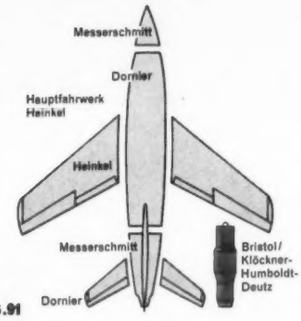


Fig. 2: G.91

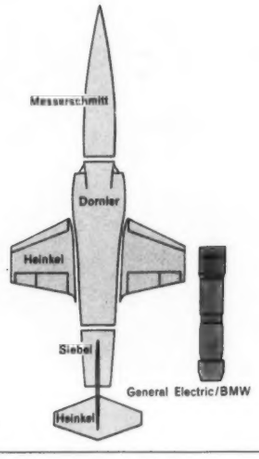


Fig. 3: F-104 G

receive a substantial portion of the production orders. More than 500 of these engines are to be built here. For testing the jets, however, the existing *Orenda* test bed (supplied by the firm of Novotechnik, Stuttgart) will not suffice, and two new benches, designed especially for the J79, as well as other equipment will have to be provided.

Klöckner-Humboldt-Deutz AG, whose head offices are in Cologne, will produce the Bristol Siddeley *Orpheus BOr.3* for the German Air Force's Fiat G.91s at its Oberursel plant. Preparations are already in progress. Although the company is working on the development of industrial gas turbines, it is not expected that Klöckner-Humboldt-Deutz will continue to devote itself to aircraft engine construction after the *Orpheus* has been phased out.

MAN Turbomotoren GmbH. A few years ago MAN acquired part of the former BMW Motorenwerke in Munich-Allach. Although today trucks are being built here, the production of turbine engines might be taken up tomorrow. The subsidiary company, MAN Turbomotoren GmbH, has signed an agreement with Rolls-Royce for technical cooperation in the continued development of the Rolls-Royce RB.153 lightweight jet, which is destined for example for the projected German VTOL single-seat combat aircraft. This work is, of course, being carried out with support from the Defence Ministry. In view of the repeatedly expressed interest of the MAN group in the BMW subsidiary, it appears possible that one day there will be a merger between MAN Turbomotoren GmbH and BMW Triebwerkbau GmbH, probably also involving the development staff of Junkers Flugzeug- und Motorenwerke GmbH of Munich.

Daimler-Benz AG, Stuttgart, has gathered together the biggest group of engineers, under Dr.-Ing. B. Eckert (late of Turboméca), at present working in the engine industry in West Germany. The company first tackled the design of a jet engine in the 2,200 lb thrust class, which was joined roughly a year ago by a propeller turbine for roughly 1,000 s.h.p. By consistently following this line of development, Daimler-Benz has succeeded in getting back into the aircraft engine field and has arrived at a formula which may arouse considerable interest tomorrow.

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The main projects of the airframe industry are thus the licence production of the 232 Fiat G.91 strike fighters by the Arbeitsgemeinschaft (Arge) 91, the licence manufacture of several hundred Lockheed F-104Gs by the Arge 104 (Süd-Gruppe) and Arge 104 (Nord-Gruppe) and the construction of the C.160 assault transport by the Transall group. Roughly a thousand modern military aircraft are thus listed in the order books for the coming five or six years.

From the summer of 1960 Fiat will begin deliveries of fifty G.91s ordered direct from Turin, to be followed from mid-March 1961 onwards by another twenty trainers. Tooling for the G.91s to be built in Germany has already begun at Dornier, Heinkel and Messerschmitt; the first metal is to be cut this summer. The distribution of production between the three above-mentioned companies within Arge 91 is shown in Fig. 2. It is not yet possible to say to what extent parts supplied by Fiat will be incorporated in the production process. It is, however, known that the engines for the first airframes built in Germany will be purchased from Bristol Siddeley and that the engines supplied by the Klöckner-Humboldt-Deutz manufacturing plant at Oberursel will not be included in the final assembly until a later date. There are also a number of equipment questions still to be cleared up, as German companies can only gradually be won over to licence production of relatively small batches of systems and equipments. The Federal Defence Ministry recently signed an agreement with the International Division of Bendix Aviation Corp., under which the latter will supply doppler navigation equipment to a total value of $2.8 million for the German G.91 programme. This equipment—together with other electronic systems—will form an integrated fighter navigation system for the G.91 and include a PHI installation by Computing Devices of Canada (a subsidiary of Bendix). Final assembly of the G.91 will be in the hands of Dornier. Flight testing of the first aircraft built in Germany and of the subsequent production models is to be carried out at the Dornier works airfield at Oberpfaffenhofen.

The F-104 programme is discussed in greater detail elsewhere in this issue. Obviously this programme requires considerable investment and a manufacturing capacity not yet achieved by the German industry, so that the two production groups, Arge 104 (Süd-Gruppe) incorporating Dornier, Heinkel, Messerschmitt and Siebel, and Arge 104 (Nord-Gruppe) with Hamburger Flugzeugbau, Weser and Focke-Wulf, will remain involved in this multi-billion project of the Defence Ministry's until at least 1965/66. The same applies of course to the engine companies and to the German and foreign equipment companies, since

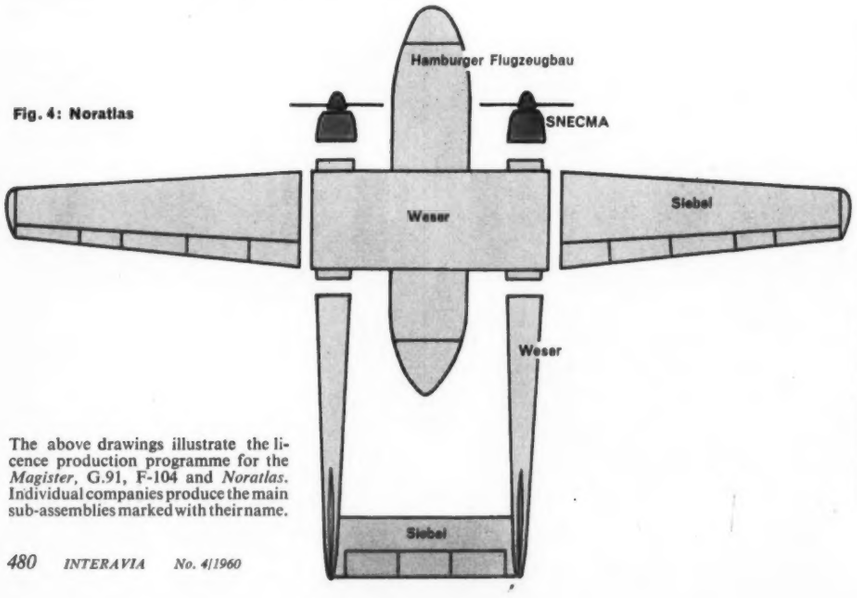


Fig. 4: Noratlas

The above drawings illustrate the licence production programme for the *Magister*, G.91, F-104 and *Noratlas*. Individual companies produce the main sub-assemblies marked with their name.

Technical data on the Transall C.160 assault transport

Powerplant

2 Rolls-Royce *Tyne RTy.20* propeller turbines, each of 5,590 s.h.p. and 6,020 e.h.p.

Dimensions

Length	101.7 ft
Wing span	131.2 ft
Overall height	38.4 ft
Wing area	1,722 sq.ft.
Aspect ratio	10

The C.160's hold is 10.33 ft wide, 9.78 ft high and 42.65 ft long; its cross-section thus corresponds to that of the standard European freight waggon. The total useful volume is 4,838 cu.ft.

Weights

Normal gross weight approx.	90,400 lb
Normal payload	17,640 lb
Maximum payload	26,455 lb
Fuel capacity	3,520 Imp.gall.

Performance

Cruising speed at 26,250 ft	270 kt
Range with 17,640 lb payload	2,430 n.m.
Take-off distance to clear a 35-ft screen	1,970 ft
Landing distance over a 35-ft screen	1,970 ft

The Transall can be refuelled in the combat zone in a bare five minutes.

Aircraft and Engines Manufactured under Licence and Maintained by the Industry

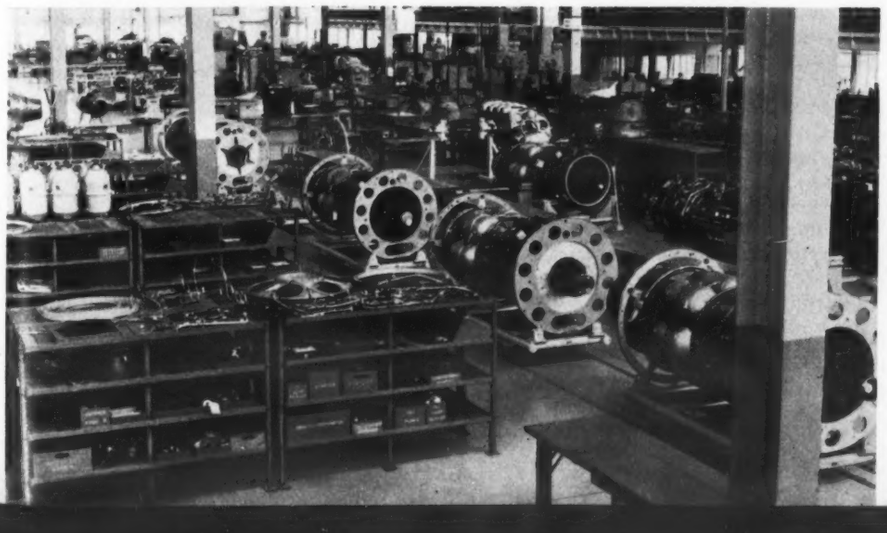
I. AIRCRAFT

Type designation	Total ordered or received	Licence manufacture	Maintenance
Republic F-84F and RF-84F	558	—	Weser Flugzeugbau GmbH, Bremen
Fiat F-86K	88	—	Dornier-Werke GmbH, Oberpfaffenhofen
Canadair Sabre 5/6	300	—	Dornier-Werke GmbH, Oberpfaffenhofen
Nord-Aviation 2501 Noratlas	129 + 16	Flugzeugbau Nord GmbH, Hamburg	Hamburger Flugzeugbau GmbH, Hamburg
Douglas C-47	20	—	Deutscher Luftfahrtberatungsdienst, Cologne/Wahn
Armstrong Whitworth Sea Hawk	68	—	Focke-Wulf GmbH, Bremen
Fairey Gannet Mk.4/5	16	—	Focke-Wulf GmbH, Bremen
Grumman SA-16A	5	—	Focke-Wulf GmbH, Bremen
Piper L-18C	40	—	Deutscher Luftfahrtberatungsdienst, Cologne/Wahn
North American Harvard Mk.IV	87	—	Messerschmitt AG, Munich
Lockheed T-33	110	—	Messerschmitt AG, Munich
Piaggio P.149D	190 + 72	Focke-Wulf, Bremen	Focke-Wulf GmbH, Bremen
Fouga Magister	188 + 22	Flugzeug-Union Süd, Munich	Messerschmitt AG, Munich
Hunting Percival Pembroke	33	—	Rhein-Flugzeugbau GmbH, Krefeld
Dornier Do 27	428	Dornier-Werke GmbH, Munich	Dornier-Werke GmbH, Munich
De Havilland Heron	2	—	Deutscher Luftfahrtberatungsdienst, Cologne/Wahn
Lockheed F-104	574 + 96	Arge 104 (Süd-Gruppe): Dornier-Werke GmbH, Munich; Heinkel Flugzeugbau GmbH, Speyer; Messerschmitt AG, Augsburg; Siebelwerke-ATG GmbH, Donauwörth. Arge 104 (Nord-Gruppe): Hamburger Flugzeugbau GmbH, Hamburg; Weser Flugzeugbau GmbH, Bremen; Focke-Wulf GmbH, Bremen	
Fiat G.91	232 + 70	Arge 91: Dornier-Werke GmbH, Munich; Heinkel Flugzeugbau GmbH, Speyer; Messerschmitt AG, Augsburg	
Bell 47G 2	20	—	Motorflug GmbH, Koblenz
Saunders Roe Skeeter	11	—	Deutscher Luftfahrtberatungsdienst, Cologne/Wahn
Sud-Aviation Djinn	6	—	Rhein-Flugzeugbau GmbH, Krefeld
Sud-Aviation Alouette II	130	—	Henschel Flugzeug-Werke AG, Kassel
Bristol Sycamore	50	—	Luther-Werke, Luther & Jordan, Brunswick
Sikorsky S-58	51	—	Henschel-Flugzeug-Werke AG, Kassel
Vertol H-21	16	—	Dornier-Werke GmbH, Munich
Convair CV-440	2	—	Deutsche Lufthansa AG, Hamburg

II. ENGINES

Type designation (for aircraft type)	Maintenance firm
Alvis Leonides M-12701-503/7 (Hunting Percival Pembroke)	Röder Präzision Wilh. Röder, Egelsbach, Hessen
Alvis Leonides M-173-524-1 (Bristol Sycamore B-171)	Röder Präzision Wilh. Röder, Egelsbach, Hessen
Allison J33-A-35 (Lockheed T-33)	AIA Casablanca
Armstrong Siddeley Double Mamba (Fairey Gannet)	Armstrong Siddeley
Continental C-90-8F (Piper L-18C)	Röder Präzision Wilh. Röder, Egelsbach, Hessen
Curtiss-Wright J65-W-7 (F-84F)	KLM Amsterdam
Curtiss-Wright J65-W-3 (RF-84F)	KLM Amsterdam
Curtiss-Wright R-1820-76A (Grumman Albatross)	Hanns Häusler, Flugmotoren-Reparaturwerk, Baierbrunn
Curtiss-Wright R-1820-84 (Sikorsky S-58)	Hanns Häusler, Flugmotoren-Reparaturwerk, Baierbrunn
Curtiss-Wright R-1820-103 (Vertol H-21)	Hanns Häusler, Flugmotoren-Reparaturwerk, Baierbrunn
De Havilland Gipsy Queen (de Havilland Heron)	Röder Präzision Wilh. Röder, Egelsbach, Hessen
De Havilland Gipsy Major (Saunders Roe Skeeter)	Röder Präzision Wilh. Röder, Egelsbach, Hessen
General Electric J47-GE-33 (Fiat F-86K)	Fiat, Turin
Lycoming GO-480-B1A6 (Piaggio P.149/Do 27)	BMW Triebwerkbau GmbH, Munich
Lycoming VO-435-A1 (Bell 47G 2)	BMW Triebwerkbau GmbH, Munich
Orenda 10 (Canadair Sabre 5)	BMW Triebwerkbau GmbH, Munich
Orenda 14 (Canadair Sabre 6)	BMW Triebwerkbau GmbH, Munich
Pratt & Whitney R-1830-90D (Douglas C-47)	Deutscher Aeroexpress GmbH, Hamburg-Fuhlsbüttel
Pratt & Whitney R-1340-AN-1 (North American Harvard Mk.IV)	Deutscher Aeroexpress GmbH, Hamburg-Fuhlsbüttel
Rolls-Royce Nene 103 (Armstrong Whitworth Sea Hawk)	S. M., Holland
SNECMA Hercules 759 (Nord Noratlas 2501)	Hanns Häusler, Flugmotoren-Reparaturwerk, Baierbrunn
Turboméca Marboré II (Fouga Magister)	Ernst Heinkel AG, Stuttgart
Turboméca Palouste (Sud-Aviation Djinn)	Ernst Heinkel AG, Stuttgart
General Electric J79-GE-7 (Lockheed F-104)	probably BMW
Bristol Orpheus BOr.3 (Fiat G.91)	probably Klöckner-Humboldt-Deutz
Turboméca Artouste (Sud-Aviation Alouette)	Ernst Heinkel AG, Stuttgart
Pratt & Whitney R.2800-CB-16 (Convair CV-440)	—

Maintenance of *Orenda* jets at BMW.



more than 40 percent of the total costs of the F-104G procurement programme will be accounted for by equipment.

If it was already found necessary in the case of the F-104G to include a number of non-German firms in this ambitious programme, the C.160 assault transport can be described as a model of international cooperation in the aviation sector, since it was tackled from the outset as a joint Franco-German project. Following an agreement by the companies concerned, the Arbeitsgemeinschaft Transall was formed on January 28th, 1959; this working group includes the firms of Nord-Aviation, Hamburger Flugzeugbau, Weser Flugzeugbau, and Blume Leichtbau und Flugtechnik GmbH —the last-mentioned as a pure development company. In mid-December 1959 the two governments signed a preliminary agreement laying down the basic principles for continued cooperation and directives for distribution of the development and production work. Under this agreement, Weser Flugzeugbau GmbH was given the overall management of the Transall project and is also to be responsible for the fuselage rears and tail units (in the latter case in conjunction with Blume). Nord-Aviation will manufacture the wings and certain components of the equipments, and Hamburger Flugzeugbau the front fuselage sections. The undercarriage with its six low-pressure tyres comes from Messier.

The development cost of the assault transport (two Rolls-Royce *Tyne RTy.20s* of 6,100 e.h.p. each) are estimated by Weser to run into 200 million DM. Of this total, however, only 6 million will be spent by November 30th, 1960. The plan calls for production of about 200 aircraft, to be preceded by the testing of at least three prototypes. The decision to have the first three prototypes constructed by three different companies —Nord-Aviation, Weser and Hamburger Flugzeugbau—appears unusual, although flight testing will apparently be carried out entirely by Nord. Nevertheless it is expected that the first flight can be made by mid-1962.

The next bigger contract group for discussion is the procurement of several hundred helicopters for the German armed services. The plan is for at least 100 assault helicopters, several dozen transport helicopters, a goodly number of crane helicopters for a payload of at least 17,000 lb and more than a hundred navy helicopters for anti-submarine warfare, which would carry search and strike equipment in the same airframe. As already mentioned, Weser—in view of its close cooperation with United Aircraft Corporation—will probably come forward with original designs at any rate in the field of the crane helicopter (advanced model of the S-64) and plans to produce the S-61 for the Army and Navy.

In addition to Weser/Sikorsky, both Vertol and Bristol are seeking orders for their YHC-1B *Chinook* and Type 192 assault helicopters respectively, while Sud-Aviation and Westland (*Frelon* and *Wessex*) are interested in the transport and naval helicopter class. Finally, Westland's *Westminster* is also being offered as a crane helicopter. Apparently the Defence Ministry would welcome cooperation in the helicopter field between Weser and Sikorsky.

In the missile sector, mention can be made at present only of two production programmes, the licence manufacture of the *Sidewinder* and of the *Hawk*. The studies carried out by Bölkow Entwicklungen KG and the considerable interest shown by certain airframe manufacturers in con-

tacts with the American, British and French missile industry leave no doubt, however, that the German aircraft industry wishes to play a leading role in the future in the missile procurement programme for the Air Force.

The *Sidewinder* air-to-air missile is being produced by Bodenseewerk Perkin Elmer & Co. at Ueberlingen, as a joint German-American programme within Phase Two of the Air Force build-up. This missile is destined to be the main armament for the German F-104G in the interceptor role, but will also be used by the air forces of other European countries, such as Denmark, Greece, Holland, Norway and Turkey. Although these countries also wish to contribute to the *Sidewinder* licence programme, Bodenseewerk will fill the major part of the European demand.

The second missile project is the well-known *Hawk* programme, which calls for licence production of this anti-aircraft weapon for Western European by Belgian, French, German, Dutch and Italian companies. Under the control of France's SETEL (Société Européenne de Téléguidage), Telefunken GmbH has for some time been engaged in preparing Germany's participation in the *Hawk*, and it does not seem unlikely that at a later date other German electronic and airframe companies may be involved in the European *Hawk* programme. Again the maintenance programme for the *Matador* and *Mace* missiles and the ordering of *Sergeant* tactical rockets should give the industry new stimulus and encourage the equipment firms which have so far taken a somewhat reserved attitude to enter the aviation business. Should the supersonic combat aircraft (with several Rolls-Royce RB.153s) projected by the Entwicklungsring Süd get beyond the prototype stage, the German aircraft industry could—from about 1966 onwards—make substantial contribution to NATO's fleet. At any rate a contribution of this kind is predicated within Phase Three of the Air Force build-up programme.

The Defence Ministry is placing great hopes in the development work being carried out by MAN and Rolls-Royce, which is aimed in part at raising the thrust of the RB. 153 lightweight jet from 3,300 lb to some 4,400 lb. Whether the General Electric J79 jet, to be built by BMW, can be developed further to power aircraft of the coming decade, i.e., for VTOL aircraft, will transpire during the next few years. General Electric is making considerable efforts in this direction, from which BMW Triebwerkbau GmbH may well benefit one day. But even disregarding the J79 series, there are several development trends emerging in the aircraft engine industry: small jets in the 100 lb thrust class (BMW), by-pass engines in the 550 to 750 lb class (BMW), propeller turbines and jets in the 1,000 h.p./2,200 lb class (Daimler-Benz), high-performance jets in the 4,400 lb thrust class (MAN/Rolls-Royce). Admittedly, at present all these are groping attempts to find a promising market, but the need to venture into original developments has unquestionably been recognized by the engine industry. Finally, it should not be forgotten that the successful Rolls-Royce *Tyne* turboprop, which has good development potential, has been selected for NATO's Breguet 1150 and the Transall C.160 assault transport, so that there seems no reason why this engine should not be produced in Continental Europe. The alliance between Rolls-Royce and MAN thus acquires double significance.

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The opinion is repeatedly expressed that the new German aircraft industry can select its field of activity and its production capacity as it thinks fit during this decisive reconstruction phase. In other words, that it could choose fields which international competition has left open. But, in the face of the highly varied military procurement programme, has the industry an adequate reserve capacity to be able to turn in good time to civil production and thus strengthen its position sufficiently to make it less dependent on the ups and downs of military and political developments? The efforts of certain Federal authorities to keep the new industry as small as possible are entirely understandable. In the nature of the aviation business, the aircraft industry is inevitably more sensitive to crises than the consumer goods industries. It is also understandable that there should be a desire to wait and see how the aircraft industry copes with the military tasks it has already been given. And finally, it may perhaps be that the considerable procurement orders will automatically lead to a consolidation of the participating companies, which will later enable them to gain a foothold in the civil sector using their own resources and investments.

But can one expect the German industry, in view of mounting international competition, to wait for years before securing itself a place in the world market for utility, business and commercial aircraft? A beginning appeared to have been made in the autumn of 1958, when the Federal Ministry of Economics invited the industry to participate in a design contest and aroused new hope with specifications for a medium-haul jet airliner and a short-range turboprop model. That the 50 million DM made available at the time would scarcely suffice for development of both a 40-ton medium-haul jet aircraft *and* a short-haul turboprop transport must have been evident from the start. At any rate, the only "promotion-worthy" design to emerge from the countless rival projects submitted for the contest was the Heinkel He 211. The parallel contest for the above-mentioned medium-haul jet aircraft for 70 to 80 passengers was won by Hamburger Flugzeugbau GmbH with its HFB 314 project, described in the following article. However, because of financing difficulties, the future of this interesting project continues to be so uncertain that for the time being only the He 211 appears to have some chance. The authorities, however, will not support further development unless Heinkel Flugzeugbau GmbH itself finds some 20 percent of the total development costs of 26 million DM approved by the Federal Government. This total is supposed to cover the whole programme, two prototypes, one airframe for tests to destruction, a pressure cabin and the flight testing.

But of what use are support for research, expansion of training facilities and contests such as thise organized by the Federal Ministry of Economics, unless the decision is made at once to accept the consequences of the evident intention to support civil development?

Admittedly, aircraft manufacturers in other European countries are also obliged to practise self-denial—leading for example to concentration of their development and production resources. But without purposeful government backing even these industries, which have been competing with each other for years and have brought out a *Viscount*, a *Britannia* or a *Caravelle*, could not plan for the future. ←

The Heinkel H 211

The He 211 short-haul aircraft projected by Ernst Heinkel Flugzeugbau GmbH, Speyer, is a shoulder-wing aircraft powered by two propeller turbines of 1,000 s.h.p. each and designed to transport 20 to 22 passengers over distances up to about 600 miles. On domestic services, however, such as the Hamburg—Hanover—Kassel—Frankfurt—Stuttgart—Munich route, the He 211 would operate over shorter block distances and hence at lower altitudes than at a range of 600 miles. Although the aircraft was originally designed to fly at altitudes of about 33,000 ft, it is now to be redesigned for inter-city traffic to operate at economical cruising altitudes of 20,000 to 26,000 ft.

A later issue of *Interavia* Review will contain a report on the design, construction and dimensions of the He 211, but a few features can be briefly mentiones here. The trapezoidal shoulder-wing is slightly depressed at the centre, the depression ending at the engines. The two main wheels of the tricycle undercarriage are retracted into the slim nacelles on the underside of the wing, the nosewheel into the front of the fuselage. The cylindrical fuselage ends in a conventional tail unit with dihedral tailplane and has ten large oval windows at each side. The design take-off run with a gross weight of 12 tons is about 2,500 ft. Empty weight will be about 7 tons.

Smaller Aircraft and Engine Companies

Aero Flugzeugbau Hubert Zuerl, Munich-Heimstetten: Single and two-seat Jodel light aircraft to German standards, components and licence plans.

Carl F. W. Borgward GmbH, Bremen: Development and construction of helicopters.

Burgfalke Flugzeugbau, Burglengenfeld, near Regensburg: Construction of sailplanes and powered aircraft, also supply of complete construction kits.

Flugzeugbau Heini Dittmar, Augsburg: Development and construction of sailplanes and powered aircraft (*Condor* and *Möwe*).

Henschel Flugzeugwerke AG, Kassel: Maintenance of Sikorsky and Sud-Aviation helicopters for the German Air Force.

Junkers Flugzeug- und Motorenwerke GmbH, Munich: Development of aircraft engines.

Merckle KG Flugzeugwerke, Oedheim, Württemberg: Helicopter development and final assembly of Bell/Agusta 47G for the German armed services.

Porsche KG, Stuttgart-Zuffenhausen: Manufacture of small air-cooled aircraft engines.

Alfons Pützer KG, Bonn: Development of powered gliders and construction of the *Elster* two-seat sports aircraft.

Raab Flugzeugbau GmbH, Karlsruhe-Durlach: Licence production of the Ambrosini F-5 and of the Bernardi *Aero Scooter*.

Rhein-Flugzeugbau GmbH, Krefeld: Construction of the RW-3 *Multoplane* sports aircraft, construction of the RF-1 small STOL transport and overhaul of military helicopters and communications aircraft.

Scheibe Flugzeugbau GmbH, Dachau: Construction of sailplane parts, sailplanes and *Sperling* sports aircraft.

Schemp-Hirth O. H. G., Kirchheim, Württemberg: Design and experimental construction of small aircraft.

Segelflugzeugbau Alexander Schleicher, Poppenhausen a. d. Wasserkuppe: Construction of sailplane parts and sailplanes.

Stark Flugzeugbau KG, Minden: Licence manufacture of single-seat small aircraft.

Glimpse of the Equipment Industry

Apparatebau Gauting GmbH, Munich: Aircraft instruments and assorted airborne and ground equipment.

ATE, Alfred Teves KG, Frankfurt: Hydraulic brakes and complete hydraulic systems, valves, piston rings, etc.

Autoflug Gerhard Sedlmayr GmbH, Hamburg: Personnel parachutes, brake 'chutes, parachute accessories, ejection seats and other safety equipment.

Robert Bosch GmbH, Stuttgart: Generators, ignition systems and other aircraft electrical equipment.

Siemens & Halske AG, Berlin: Telecommunications and telemetering equipment.

Siemens-Schuckertwerke AG, Berlin: Airport lighting equipment and other high voltage installations for air traffic control, electrical installations for hangars, arc and resistance welding equipment, etc.

Standard Elektrik Lorenz AG, Stuttgart-Zuffenhausen: Communications equipment for aviation use, short distance and long distance navigation equipment, etc.

Strüver GmbH, Hamburg: Airfield fuelling trucks, diesel-electric power supply systems and starter sets for all aircraft types.

Telefunken GmbH, Ulm: Navigation and radar equipment and other instruments and installations for telecommunications.

F-104G
A Joint European Programme

In a few years' time almost a thousand Lockheed F-104G fighter-bombers will be stationed on the airfields of the German, Netherlands and Belgian Air Forces—not to mention the 200 Canadian CF-104s destined for RCAF units in Europe. For the first time four NATO member States will have standardized modern aircraft built and placed in service by themselves. The F-104G programme is, however, not only the first major joint European aircraft procurement programme since the NATO G.91 strike aircraft, but at the same time a project involving vast expenditure, which promises to keep large sectors of the German, Netherlands and Belgian aircraft industries busy for some years to come.

Interavia has already discussed the F-104 *Starfighter* programme on several occasions, but a brief recapitulation of the history of the "European" F-104G's development is nevertheless given in these pages. After the German Air Force Staff and the Technical Department of the Federal Ministry of Defence had made a thorough two-year study of the aircraft types produced by Germany's NATO partners (plus the Swedish *Draken* supersonic fighter), they finally selected the Lockheed F-104G in October 1958. The choice was in part dictated by the fact that the F-104 was already in production and in service with the USAF Tactical Air Command and Air Defense Command. It was, however, clear at the outset that the F-104, originally designed as a pure day fighter, would have to be modified to fulfil German Air Force requirements, and that the modifications would have to be carried out in close collaboration with the American manufacturers and the U.S. Air Force.

To meet the German specifications for a single-seat multi-purpose combat aircraft capable of interception, fighter-bomber, and general and naval reconnaissance missions, certain alterations had to be made to the original F-104 airframe, including reinforcements of the tail unit, fuselage and wing attachments. The 104G's equipment, too, differs substantially from that of its forerunners, the 104A and C. The entire navigation equipment (including the inertial system and the autopilot), the fire control system, the homing devices, the flight data computer and the ejection seat, had to be either modified or replaced outright. For safety reasons and for the purpose of standardizing all German military flying equipment, the Martin-Baker upwards-ejecting seat was finally chosen.

When the most important points of the licence production programme were settled, and agreement was reached on the modifications required, the Bundestag Defence Committee approved the following procurement programme:

- 30 F-104B trainers, to be delivered by Lockheed from mid-1960 onwards (at a price of about DM 4.16 million[1] each);
- 6 F-104s for experimental purposes, also to be delivered by Lockheed, from 1961 onwards (average price DM 5.72 million each);
- 60 F-104s to be ordered from the USA for the formation of the first basic squadron;
- 210 F-104Gs, to be manufactured by Arge 104 (Southern Group), a consortium of the firms of Dornier, Heinkel, Messerschmitt and Siebel formed especially for the purpose (price of a complete aircraft, with equipment, approx. DM 6 million).

For the last 210 aircraft the Federal Ministry of Defence is paying Lockheed an initial overall royalty of DM 4.2 million, and a royalty per airframe of DM 63,000. The Federal Government will have to make a down payment of DM 12.6 million for the 295 General Electric J79 engines for the first German-built F-104 series, and a separate payment of DM 32,000 for each engine from the 296th onwards. Apart from these payments, Germany must bear the greater proportion of the costs of developing and testing the new F-104G. When other countries subsequently adopted the multi-purpose version of the F-104 as the standard single-seat combat aircraft for their air forces, they were naturally expected to share in the development costs in proportion to the number of aircraft ordered. The efforts of the Federal Ministry of Defence were, however, aimed at a joint European production programme to stimulate the aircraft industries of all the countries concerned and keep them sufficiently occupied for many years to come.

For this reason the additional 364 F-104G fighter-bombers which have been approved for the second supplement to the German Air Force programme are to be built jointly with Netherlands and Belgian firms to fit in with these two countries' own production programmes. In Germany this part of the programme will be dealt with by Arge 104 (Northern Group), a consortium consisting of Hamburger Flugzeugbau, Weser Flugzeugbau and Focke-Wulf; in the Netherlands the firms of Fokker, Aviolanda and Philips will participate in the project, and the Belgian share in the contract will go to Fairey, SABCA and Fabrique Nationale d'Armes de Guerre (FN). On March 5th, 1960 the Defence Ministers of West Germany, Belgium and the Netherlands signed an agreement at Cologne Airport governing the joint production of a total 739 *Starfighters* for the air forces of the three countries. Under the agreement the German Air Force will receive 364 aircraft (those ordered under the second supplement to the re-equipment programme), the Netherlands Air Force will purchase 200 and the Belgian Air Force 175. An office is to be opened in Koblenz to coordinate joint F-104 production and deal with all problems arising out of licence manufacture; its members will consist of representatives of the three States concerned, their national industries and Lockheed Aircraft Corporation.

Under present planning, the General Electric J79 engines are to be produced by BMW Triebwerkbau GmbH at Munich-Allach and by the Belgian firm FN at Herstal. Although FN has already built complete Rolls-Royce *Avon* jet engines under licence, BMW's post-war activities in the field of jet powerplants have consisted solely in the overhaul of Orenda engines. The decision to produce a high-performance jet engine such as the J79 in Germany can be explained above all by the wish to resume turbine production, interrupted since the war, and to make it easier for technicians to familiarize themselves with this technologically complex field.

As over 40 percent of the total procurement cost of the F-104G is accounted for by the equipment, its licence production should be of considerable interest to the firms concerned, as they will have a better opportunity than hitherto to become acquainted with the latest American developments.

The flight testing of the F-104G, too, will provide the European air forces and industry with valuable experience. The test programme provides for three phases: In the first phase the separate components of the aircraft will be rigorously tested at Palmdale, near Los Angeles, at so-called plant tests. Next, evaluation flights will be made by German, Canadian and U.S. pilots; responsibility will be in the hands of the two former, the USAF acting in an advisory capacity. The second phase consists in testing the weapons system at Edwards U.S. Air Force Base. Here the responsibility will lie with German pilots. In the third phase the complete weapons system will be given operational trials which will, as far as possible, be conducted in Germany.

Under the agreement signed by the three Western European Defence Ministers on March 5th, 1960, the Federal Republic placed orders in the Netherlands on March 11th for an initial series of 127 F-104G single-seat combat aircraft with a total value of 740 million guilders[2]. Of this sum 400 million guilders will go to the main contractors, Fokker and Aviolanda, which in their turn will award subcontracts to the members of the German Arge 104 (Northern Group). A further 135 million guilders of the German order will go to Philips, which is to build parts of the electronic equipment (apparently including the Super-NASARR R-15A multi-purpose radar) and 205 million guilders to various subcontractors. No contractors have yet been named for the jet engines. It is also reported from The Hague that the Netherlands Defence Ministry is to have an initial 50 F-104Gs built under licence in Holland for the Royal Netherlands Air Force at a price of 300 million guilders.

Thus about a thousand European-built F-104s are to be ready by the mid-sixties—a procurement programme which, with an average price of DM 6 million per aircraft and including the spare engines, spare equipment and ground support equipment, should cost about DM 10,000 million... not to mention the substantial funds required for training pilots, preparing the ground organization and operating and maintaining this impressive fleet. The defensive armament policy of Western Europe is costly—but the standardization attempted in the shape of the F-104 programme would seem to be well worth the expense. ←

[1] DM 1 million = U.S. $ 238,100
[2] 1 million guilders = U.S. $ 263,160

A German Proposal for a Medium-Haul Jet: The HFB 314

Since autumn 1958 a number of West German aircraft manufacturers have been working on projects for short- and medium-haul airliners at the request of the Federal Ministry of Economics (cf. *Interavia* No. 11/1959). Their studies have resulted in two designs: the Heinkel He 211 twenty-passenger short-range turboprop aircraft, which is discussed elsewhere in this issue, and Hamburger Flugzeugbau GmbH's HFB 314, a medium-haul jet aircraft for 70 to 80 passengers. Although at the moment it is not certain whether development work on the latter project will continue in view of inadequate Government backing, its interest is such that it merits a review in these pages.

Hamburger Flugzeugbau GmbH, founded in 1933 by the well-known Blohm & Voss shipyards and run during the war as a division of the latter firm, resumed operations in 1956 at its former plant at Hamburg-Finkenwerder, turning to the development of commercial aircraft. After designing a twin-engine turboprop aircraft, the HFB-C-209 (developed from the Spanish C-207 *Azor* with two Napier *Elands*), Hamburger Flugzeugbau set to work two years ago on the HFB 314.

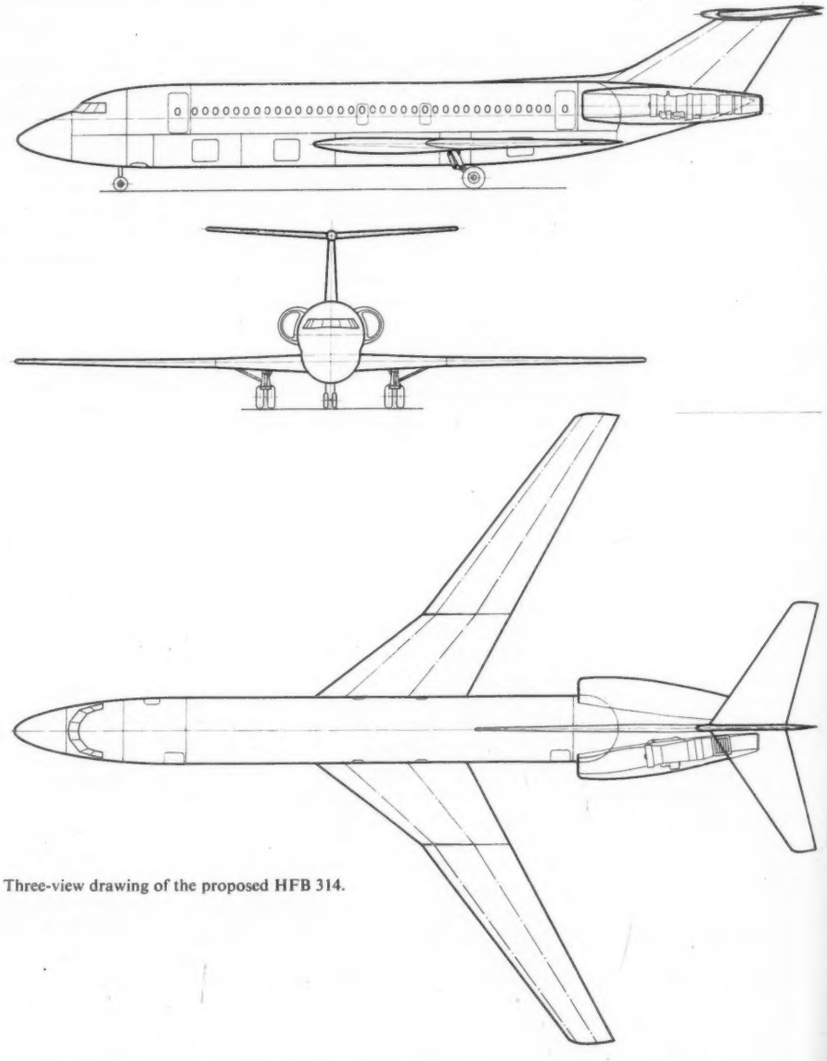
The firm feels that there is sufficient need for an aircraft which can transport 70 tourist-class passengers over distances of 300 to 1,200 miles at cruising speeds around 600 m.p.h. to justify the relatively high development costs and capital investment necessary for quantity production. This is on the assumption that air transport—on international routes, at any rate—will make increasing use of jet propulsion, and that the requirement for medium-haul aircraft in the foreseeable future will be of the order of several hundred.

A cruising speed of 600 m.p.h. would considerably reduce flight times on stage lengths of about 1,200 miles, for instance on services between European capitals. The same aircraft could operate once daily in each direction on routes such as Frankfurt–Madrid or Frankfurt–Rome–Cairo with, say, a five-hour stop at its destination. What is more, the HFB 314's cruising speed is in the high subsonic range; and since air trips at Mach 2 are out of the question at present and will be possible in future only over very long stages, aircraft such as the HFB 314 can be expected to enjoy a long and profitable life. With the 70-passenger layout, the designers contend, the load factor can be increased on short and medium stages by using smaller aircraft and raising the frequency of services.

The designers of the HFB 314 aim at achieving the relatively high cruising speed by using a high-speed wing, choosing the optimum fuselage fineness ratio and designing the aircraft to the area rule. HFB tested a whole series of different wings for drag and flight qualities at high and low speeds before selecting the present wing, which, with a thickness/chord ratio of 9 to 10 percent, has an effective sweep of 48° inboard and 35° outboard. Extensive wind-tunnel tests have been made at Mach numbers corresponding to the maximum cruising speed, and the Aerodynamic Testing Establishment at Göttingen is now conducting research to determine the optimum slow-flying qualities.

The wing has been fitted with double slotted landing flaps to achieve the greatest possible speed range. The rear-mounted engines and the use of spoilers for lateral control (short ailerons are provided for slow flight) has enabled the wing to be left clear so that the landing flaps can be fitted across almost the entire span. The wings have leading edge flaps to further improve the lift coefficient at take-off and landing and to ensure that optimum flying qualities are maintained during the rest of the flight.

The fuselage was originally designed to take five passenger seats in each row but, on the basis of recent experience, the diameter has been reduced to take only four seats per row, thus meeting European requirements for increased comfort. Although this alteration has meant certain concessions as regards structural weight per passenger and optimum



Three-view drawing of the proposed HFB 314.

load factor, it has made possible an improvement in the fineness ratio and a corresponding rise in the critical Mach number.

Special attention has been paid to the requirement of economy of operation with low passenger load factors. A double-bubble fuselage section has been chosen to provide large-capacity freight holds under the passenger cabin, so that enough freight can be carried if the passenger load factor is inadequate. According to the designers' calculations, the 70-seat tourist version of the HFB 314 would cover its operating costs if it carried only 30 revenue passengers and no additional freight. If two tons of extra freight were carried, the aircraft could still cover operating costs with only twelve passengers.

The powerplant would probably consist of two by-pass or turbofan engines in the 14,000 to 18,000 lb thrust class, and consideration is being given to the Rolls-Royce RB.141/3 and RB.141/11, the General Electric CJ-805-23 and the Pratt & Whitney JT3D-3. In contrast with current practice, which tends to fit the engines in nacelles at each side of the fuselage, it is planned to fit the HFB 314's engines at the rear of the fuselage, directly behind the rear pressure cabin bulkhead. Studies conducted jointly with General Electric have revealed that the layout selected will achieve considerable economy as regards fuel consumption and engine installed weight, as the boundary layer air is removed from the fuselage and combined with the exhaust gas stream. The jet engines are suspended from T-shaped pylons in such a way as to be easily accessible and interchangeable.

The horizontal tailplane above the rudder assembly enables the thrust reversers of both engines to be actuated without appreciable effect on the air flow around the horizontal stabilizer. This design should considerably reduce the landing distance. All the HFB 314's internal systems, i.e., the electrical installations, electronic equipment and hydraulic and air conditioning systems, have been arranged with a view to rapidity of maintenance. Each installation or system is designed as a compact unit and enclosed in a compartment under the cabin floor. Maintenance can be carried out from the ground via access hatches without special equipment.

On completion of the reconstruction phase of the German aircraft industry, which is characterized by the construction of foreign aircraft types under licence, the development of an aircraft of this kind would be well within the bounds of possibility. Both the technical and scientific basis and the production capacity for such a programme are at hand, and the relatively favourable wage situation in the German industry, coupled with the fairly low overheads in development plants, would enable an aircraft such as the HFB 314 to be produced at an interesting price. ⟷

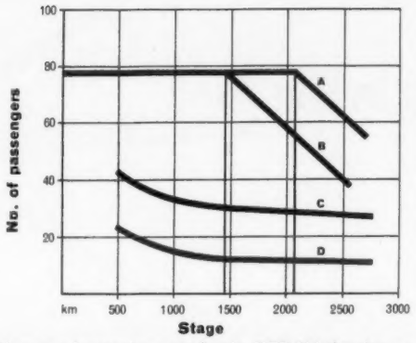
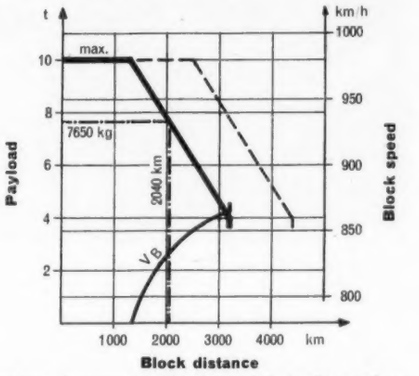
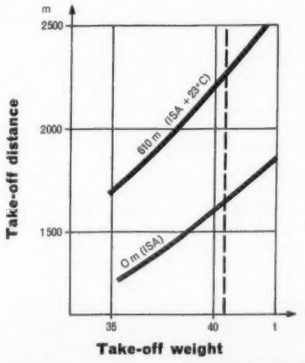


Diagram of operating costs for the HFB 314 showing, as a function of stage length (in kilometres), maximum permissible number of passengers, and minimum number of passengers required to break even. (A) Maximum number of passengers without freight; (B) with two tons of freight. (C) Number of passengers required to cover all operating costs without additional freight; (D) with two tons of additional freight.



Payload (in tonnes) and block speed (in km/h) as a function of range (in km). The heavy line shows the maximum payload with fuel reserves of 3,750 kg (8,250 lb), the dotted line the maximum payload without fuel reserves. Block speed V_B reaches an optimum at a block distance of about 3,200 km (2,000 miles). With a payload of 7,650 kg (16,850 lb) and a cruising altitude of 11 km (36,000 ft) a block distance of 2,040 km (1,270 miles) could be obtained.



▲ Take-off distance to clear a 10.5 m (35-ft) screen (in m) as a function of all-up weight (in tonnes) under ISA conditions at sea level and at ISA + 23° C at an altitude of 610 m (2,033 ft) above sea level.

Technical Data for the HFB 314

Powerplant

2 × Rolls-Royce RB.141/3 or 11 (take-off rating 2 × 14,100 lb or 15,500 lb) or

2 × General Electric CJ-805-23 (take-off rating 2 × 16,100 lb) or

2 × Pratt & Whitney JT3D-3 (take-off rating 2 × 18,000 lb)

Dimensions and characteristics

Wing span	93.2 ft
Overall length	118.9 ft
Wing area	1,232.3 sq.ft.
Aspect ratio	7
Thickness/chord ratio	9—10 percent
Wing loading	72 lb/sq.ft.
Power/weight ratio	3.14 lb/lb

Passenger and freight capacity

First class	60 passengers
First + tourist class	28+36 passengers
Tourist class	70 passengers
Economy class	78 passengers
Freight and luggage holds	875.8 cu.ft.

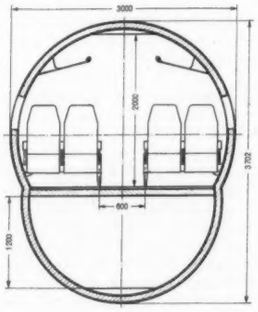
Weights

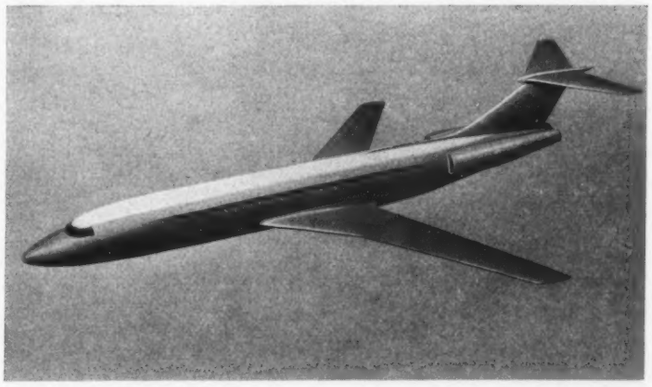
Airframe	24,955 lb
Engine	10,052 lb
Equipment	8,575 lb
Empty weight	43,582 lb
Crew	1,145 lb
Service equipment	1,355 lb
Operating empty weight	46,082 lb
Payload	22,045 lb
Max. zero fuel weight	68,127 lb
Max. take-off weight	88,740 lb
Max. landing weight	83,800 lb
Max. fuel weight	35,800 lb

Performance (with two Rolls-Royce RB.141/3)

Average cruising speed at 36,000 ft	590 m.p.h.
Maximum cruising speed at 23,000 ft	610 m.p.h.
Range with 70 passengers and 5,500 lb luggage and freight	1,270 miles
CAR take-off runway length to clear a 33.6 ft screen (with take-off weight of 88,740 lb)	5,250 ft
Landing distance over a 33.6 ft screen (at landing weight of 83,800 lb)	5,050 ft

Fuselage cross-section. Dimensions in millimetres.





Model of the HFB 314. ▶

What's in the Air?

● **British Overseas Airways Corporation's** full fleet of 15 Boeing 707-420s will first become available in the summer of 1961. At that date BOAC plans to operate thirty Boeing 707 and fourteen *Britannia 312* services (and no *Comets*) weekly on the London–New York route alone. The 707s are scheduled to operate more than eleven hours a day during the summer. On the westbound London–New York sector, 1959–60 passenger volume has increased by 14.5 percent over the previous year and is forecast to increase by a further 16 percent in 1960–61 and a further 24.5 percent in 1961–62. For the period between April and September 1961 the actual passenger potential travelling from the United Kingdom on services terminating on the United States East Coast is estimated at 161,000 passengers. BOAC's share of the North Atlantic market has shown a steady growth from 31 percent in 1957 to 38 percent in 1959 and is estimated at over 40 percent for the coming summer; for the peak season 1961, the figure will probably reach 45–46 percent. Applying this latter percentage to the 161,000 westbound travellers from London, BOAC expects to get 77,000 passengers in the summer of 1961. On the same route in 1959, BOAC carried 41,500 passengers and, before the Boeing 707 delay upset calculations, had expected a passenger volume of 60,000 for this year. BOAC will have a capacity of 117,000 seats in summer 1961, and 77,000 passengers would give a load factor of about 66 percent.

● **British European Airways** plans to start bus service-type flights on an experimental basis on a U.K. domestic route this spring. BEA Chief Executive Anthony Milward has said that the Vickers *Vanguard* would be an ideal aircraft for this type of service and would result in a considerable saving in paper work. BEA plans to build up London–Paris services next year with *Vanguard* flights from Gatwick, and the bus service may also be applied to these operations.

● **Airwork and Hunting-Clan Air Transport,** two of Britain's largest independent airlines, have announced agreement in principle on a merger of their air transport interests. This merger is the first major step in Minister of Aviation Duncan Sandys' planned reorganization of the British independents. The Airwork Group's main operating companies are Airwork, Air Charter, Transair, Malton Air Services and Olley Air Service. Operations covered by the merger plan will probably include: 1) existing scheduled services such as the three joint Airwork/Hunting-Clan Safari operations from London to East Africa (Nairobi), Central Africa (Salisbury) and West Africa (Accra); 2) the Hunting-Clan all-freight Africargo service from London through Africa to Johannesburg; 3) Hunting-Clan's Colonial Coach service to Gibraltar; 4) the two companies' trooping contracts to the Far and Middle East; and 5) the Channel Air Bridge car ferry services to Continental Europe. Under the merger, the two independent operators will produce a joint fleet of some 43 aircraft including four Bristol *Britannias*, ten Vickers *Viscounts* and two DC-6As. Airwork's helicopter activities (Bristow Helicopters and Fison-Airwork) are reportedly not involved in the merger. The future position of Hunting-Clan Air Carriers, formed in Rhodesia in January this year by the merger of Hunting-Clan African Airways and Air Carriers, is not yet known. Both Airwork and Hunting-Clan have submitted applications to operate "very low fare" services between the U.K. and various colonial points; no decisions have yet been announced, and it is not yet known to what extent the merger will affect these plans.

Swissair Flight Captain Walter E. Borner has six million flight kilometres to his credit, and has spent almost 20,000 hours at the controls of all kinds of aircraft. He has been in service with Swissair since December 1st, 1933.

● **Sabena's summer timetables** (April 1st to October 31st) will bring a staged increase in Boeing 707-329 services on the Brussels–New York run up to a frequency of 14 flights per week, seven services weekly Brussels–Léopoldville, and twice-weekly services Brussels–Johannesburg. Sabena's jet operations will be gradually extended to include service to Montreal and later Manchester on the North Atlantic run, and to Elisabethville on the Brussels–Léopoldville run, with three intermediate stops at Lisbon, Rome and Athens. The Boeing 707 will cut Brussels-Moscow time down to three hours, and from April 6th Sabena will offer direct service New York–Moscow in 9 hours 45 minutes. The bulk of Sabena's European services will be performed with DC-6s and DC-7Cs, and the carrier will again operate seasonal services to Lourdes, Salzburg and Naples, as well as from four U.K. points (London, Manchester, Glasgow and Southend) to the Belgian coast. Far and Middle East services will also be operated by DC-6s and DC-7Cs, and the Convair 440s will be employed on regional services in the Belgian Congo. Services from Belgium to the eastern Congo will all terminate at Usumbura and Elisabethville in future. Sabena is also seeking the necessary Government approval for the operation of twice-weekly services to Benghazi via Tripoli.

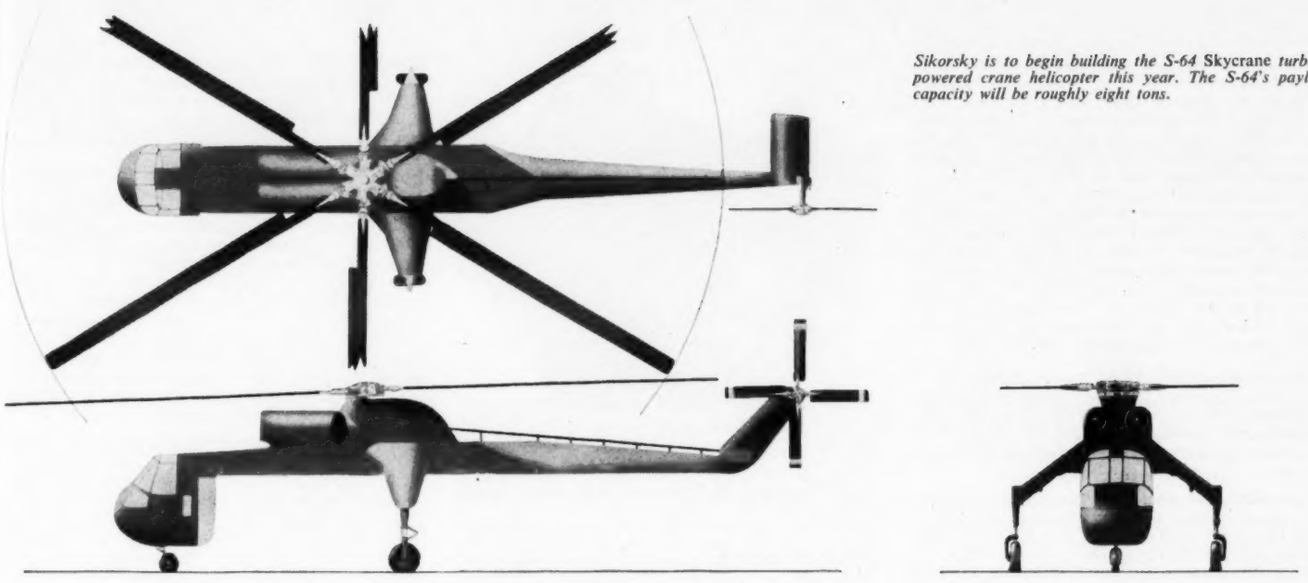
● **Deutsche Taxiflug GmbH,** of Kehl am Rhein, founded last November, was due to begin operations from Mannheim-Neuostheim on April 1st with a fleet of 8 to 10 Dornier Do 27s, to which four Do 28s are to be added later. The following operations are planned: Hanover Trade Fair taxi service; feeder services from Düsseldorf, Essen-Mülheim, Hanover, Bremen and Hamburg to the Frisian Islands and Heligoland; taxi services from Munich to Oberammergau; charter flights from Mannheim, mainly as feeder services to Frankfurt, Stuttgart and Düsseldorf. Until the company's own hangar is available at Mannheim, maintenance will be carried out at Dornier's Munich-Oberpfaffenhofen works.

● **The Verband der Deutschen Luftfahrtsunternehmen** (Association of West German Airline Operators) has set up a local Services Working Committee including the following members: Claus Kühl (Deutsche Taxiflug GmbH), von Pappenheim (Deutsche Nahluftverkehrsgesellschaft), and H. Weber (Nordwestflug GmbH). The committee is to promote extended air taxi services within the Federal Republic this summer, as a step towards the eventual development of scheduled local services.

● **Finnair** withdrew service from Geneva on April 1st, but is continuing to serve the Helsinki–Copenhagen–Frankfurt route with the *Caravelle* in place of the Convair 440 *Metropolitan*. On April 23rd Finnair is due to introduce a new night service Helsinki–Malmö–Zurich and return, operated each Saturday with Convair 440s; from May 11th the frequency will be increased to twice-weekly, with a *Caravelle* service operated each Wednesday night. As a result of the cancellation of Finnair's Geneva service, the carrier's local office will be closed down in mid-April and reopened in Zurich. Finnair's second *Caravelle* was due for delivery on March 15th, and the third on April 10th. From April 18th the carrier will operate the *Caravelle* on a daily service Helsinki–Hamburg–Amsterdam, continued four times weekly on to Paris and three times weekly to London.

● **Japan Air Lines** now plans to inaugurate DC-8 service on the Tokyo–San Francisco route on August 11th, slightly over a month later than the originally planned date. JAL jet services between Tokyo and Los Angeles, and Tokyo and Seattle will start in September and October respectively. By mid-October the carrier will be operating three flights weekly to San Francisco and to Los Angeles, and two flights weekly to Seattle. In mid-November another jet flight each week will be added to the Tokyo–San Francisco service, bringing JAL's total trans-Pacific jet flights to nine weekly. Also in November JAL plans to inau-

The Chance Vought F8U-2N Crusader *carrier-borne fighter began flight tests in mid-February. This latest version is equipped with an improved angle tracking radar with considerably longer range than that installed in the earlier models, the F8U-1 and F8U-2. The F8U-2N, which is scheduled for delivery to the U.S. Navy later this year, has an increased fuel capacity and is powered by a Pratt & Whitney J57-P-20. During 1959 Chance Vought received Navy contracts for the F8U-2N totalling approximately $100 million, which will extend production through 1961.*



Sikorsky is to begin building the S-64 Skycrane *turbine-powered crane helicopter this year. The S-64's payload capacity will be roughly eight tons.*

gurate twice-weekly DC-8 flights between Tokyo and Hong Kong. The planned twice-weekly DC-8 service on the Polar route to Europe will not come into effect until the spring of 1961, when the full fleet of five DC-8s is available.

● **Pan American World Airways** will operate 40 flights weekly from London to the United States this summer, 34 with jet aircraft. Three flights daily will be operated to New York, one via Boston; once daily jet service to Chicago, and six jet flights weekly over the Polar route to the U.S. West Coast. Pan American is also scheduling 21 jet flights weekly to Europe and six weekly to the Middle and Far East. The carrier plans to introduce the Douglas DC-8 on its trans-Atlantic routes this month.

● **Trans World Airlines** will add three more Boeing 707 services between New York and London each week for a total of ten flights weekly, effective April 24th; from May 18th frequency will be increased to 14 round trips a week. One daily service will be operated to Frankfurt. Also on April 24th, TWA will double New York–Paris non-stop jet frequency to two round trips a day, with one flight daily continued on to Rome as at present. The other seven flights on the New York–Paris run will offer connections to Milan, four routed via Geneva and the other three via Zurich.

● **A project for a new Paris airport** has been announced by Pierre D. Cot, Director General of the Paris Airport Authority. The requirement for the new airport was first made known in early 1959, when the Paris municipal authorities made a claim to some 1,500 acres of land around Le Bourget Airport for housing development. The Paris Airport Management Board was instructed to draw up plans for a new ICAO Category A airport to be located to the north of the city, and this has now been completed. The location chosen is 15 miles from the centre of Paris (Notre Dame), as compared with Le Bourget's 10 miles. The total area of the land required for the project would be at least 6,000 acres, and provision would also have to be made for the later extension of the main runways to a total length of 16,400 ft. The new airport could be ready for use in 1967, when it would completely replace Le Bourget. Estimated cost is 500 million New Francs, excluding the cost of moving the military installations now at Le Bourget. Estimated figures for the future passenger traffic volume at the Paris airports are 5 million by 1964, 10 million by 1975 and around 12 million by 1980, calculated on the basis of the 2.5 million passengers recorded in 1957. It has been estimated that aircraft movements at the new Paris-Nord airport would run at the level of 200,000 in 1975, and 220,000 by 1980. The Paris Airport Management Board calculates that the 12 million passengers estimated for 1980 would be divided between Paris-Orly and Paris-Nord in the ratio of 8 million to 4 million.

● **New York International Airport's** new instrument runway (4R-22L) was taken into operation in mid-February. It has narrow gauge lighting and centreline lighting fixtures flush with the runway, in addition to the conventional high-intensity runway edge lighting, and high-speed taxiway exits with blue columnar edge lighting. A 3,000-ft approach light lane is installed on a pier jutting out into Jamaica Bay. The new runway is 8,400 feet long and located parallel to and 3,000 feet to the east of the former instrument runway (4L-22R); the two runways will be operated as a dual system, and parallel alignment will permit instrument landings on 4R-22L while take-offs are being made on 4L-22R. The dual runway system is also aligned with instrument runways at La Guardia and Newark Airports to facilitate the simultaneous handling of instrument air traffic at all three airports.

● **The Canadian Government** has served notice that a charge of $64 will be levied on any aircraft which overflies Gander Airport and makes use of the navigational facilities there. The United States Government is protesting against the Canadian action, on the grounds that it would set a dangerous precedent.

● **The 13th Annual Technical Conference** of the International Air Transport Association, to be held in Lucerne, Switzerland, from May 2nd to 10th, will be mainly concerned with study of the member carriers' experiences in the first year of world-wide jet operations. Special attention will be given to more efficient use of the upper air space in which the jets operate and to consideration of the impact of jet operations on the internal structures and procedures of the carriers' technical and operating departments. Approximately 300 technical and operations experts will attend, and the meeting will be under the chairmanship of SAS Vice President Knud Hagrup, Chairman of the IATA Technical Committee. Principal items on the agenda include: 1) exchange of views on the application of doppler navigation systems, heading reference devices, navigation computers and information display; 2) air traffic control and associated services in the upper airspace and terminal areas as affecting turbine-powered aircraft; 3) cockpit design and layout, and flight information presentation; 4) flight dispatch procedures and flight and take-off planning techniques; 5) apron and maintenance area problems; 6) maintenance and related engineering improvements; 7) airborne recorder requirements; 8) engineering and maintenance aspects of aircraft pooling and interchange agreements; 9) jet crew training; 10) minimum noise techniques; 11) aircraft turbine fuel requirements.

● **BOAC, Air-India and Qantas** have reached agreement on all details for the three-carrier pooling set-up worked out in Bombay last December. The three carriers' joint schedules were due to come into effect on April 1st, and—as announced earlier—the partnership will cover services between Britain, the Far East, Australia and some North Atlantic services. The carriers have also agreed on additional freight services between Europe and Australia.

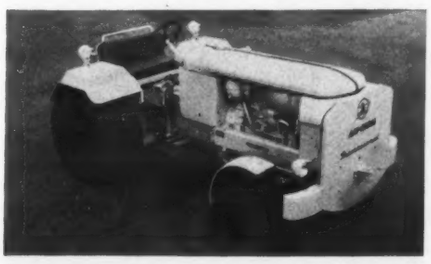
● **The Bulgarian national carrier TABSO** will operate a twice-weekly Ilyushin Il-14 service on the route Sofia–Vienna–East Berlin–Copenhagen, beginning in April.

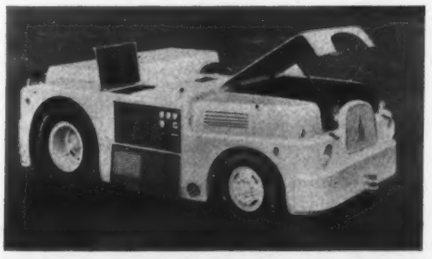
● **East European Pool:** Representatives of the Bulgarian, Hungarian, Polish, Rumanian, Czechoslovak and East German airlines met in Warsaw in mid-March to discuss the pooled operation of air services between Warsaw, Prague, Bucharest, Budapest, Sofia and East Berlin.

● **Società Aerea Mediterranea** is a new air transport company which has been registered in Rome with a capital of 100 million lire ($160,000). A company of this name existed in Italy before World War II, but was later merged with other carriers to become Ala Littoria, itself liquidated after the war.

● **Air France** has taken delivery of a Curtiss-Wright Boeing 707 simulator; cost was 4 million NF ($800,000), plus spares valued at 300,000 NF ($60,000).

● **Convair's first 600 jet transport** moved onto the assembly line at the beginning of March as the two wing sections went into mate. Meanwhile, wings for the second 600 are already in the wing bucks. A Convair 600 will be moving down the line in between every fourth or fifth Convair 880.





Klöckner-Humboldt-Deutz will be exhibiting the Magirus-Deutz Orion 250 *and* Orion 70 *series of aircraft towing vehicles at the Hanover Air Show. The new* Orion 250 *(left) is designed for towing turbine-engined aircraft and is powered by a 250 h.p. air-cooled Deutz diesel. Its total weight is 35,410 lb. The entire aircraft ground power supply is provided by a built-in multi-phase generator unit. The 70 h.p.* Orion 70 *(right) is designed to two piston-engine aircraft. It has a total weight of 13,890 lb.*

● **D. Napier & Son Ltd. and Westland Aircraft Ltd.** are working, with Ministry of Aviation backing, on the design of a de-icing system for the Westland *Wessex* helicopter. The system is based on Napier *Spraymat* electrical surface heaters, and at present the project is confined to the design and testing of three sets of heaters for the main and tail rotors and the associated control and switching system. One of the heaters will be ground tested on the Napier rotor test tower at the company's Flight Development Establishment at Luton. The other two sets will be flight tested, one in England during the summer of 1960, the other in Canada for cold weather trials in early 1961. On completion of the programme, it is envisaged that in its developed form the *Spraymat* heater system may be fitted as standard to later marks of the *Wessex*.

● **The Dassault Mirage IV-01** two-seat bomber (2 × SNECMA *Atar 9*) has completed works tests and has been handed over to the Istres Flight Test Centre for official testing. During works tests the *Mirage IV-01* flew at speeds around Mach 1.9 for a period of 18 minutes.

● **At Canadair Ltd.** a water tank is under construction for static and fatigue tests of the fuselage of the CL-44 freighter aircraft. This tank, first of its kind in Canada, will be just over 141 ft long and 23 ft wide, with a side extension of 33 ft at one end to make room for the aircraft's swing tail. Water will be drawn from or returned to an adjoining reservoir, which will be 50 ft in diameter and 30 ft high with a capacity of 346,300 gallons. Canadair's engineering laboratories designed the tank and reservoir; a Montreal firm, Dominion Bridge Co., is building the tank at a cost of $140,000. The entire programme is expected to cost more than $1 million and will continue through 1961. The forward section of the CL-44 fuselage is scheduled to go into the tank early in May this year, the rear section in July, 1960.

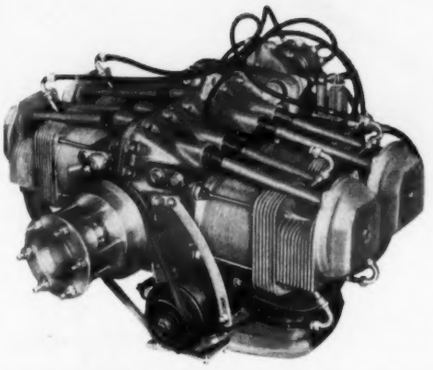
● **The U.S. Federal Aviation Agency** has granted the three-seat Hiller 12E helicopter certification (with immediate effect) for an increase in gross weight from 2,700 lb to 2,750 lb. The result of the increase is an improvement in payload capacity. The 12E is powered by a 305 h.p. Lycoming V0-540, though a series of "growth kits" will soon be available to enable 12E owners to increase engine power to 340 h.p. A cabin kit to enlarge the basic 12E from a three-seat to a four-seat aircraft will also be placed on the market in the near future.

● **A miniaturized liquid level sensing system** for all fuels and oxidizers in common use has been developed by the Aeronautical Division of Minneapolis–Honeywell Regulator Company. The unit is designed for use on aircraft, missiles and ground support equipment; the sensor will operate over temperatures ranging from —420°F to +1,100°F; response time can be varied from 10 milliseconds to 4 seconds, as required, with an accuracy of ±0.05 in. Power consumption is 0.33 watts on d.c. systems and 0.5 watts on a.c. systems; weight is 5.5 oz.

● **The latest issue of Vanguard 950 Mk. 2 specifications** (the version offered for delivery in 1961) gives the following increases in maximum weights: gross take-off weight 146,500 lb (an increase of 5,500 lb); max. landing weight 130,500 lb (an increase of 9,500 lb); max. zero fuel weight 122,500 lb (an increase of 10,000 lb); max. payload 37,000 lb (an increase of 8,000 lb). These improvements have been achieved with an actual empty weight increase of only 600 lb.

● **The U.S. Air Force** has announced its decision to proceed with the development programme for the GAM-87A *Sky Bolt* air-launched ballistic missile. Douglas Aircraft Co. is prime contractor, while Northrop Corp.'s Nortronics Division is responsible for the weapon's guidance system; several other contractors—General Electric, Aerojet-General etc.—are also cooperating in the programme. *Sky Bolt* is a two-stage solid-propellant missile capable of high supersonic speeds and ranges of up to 1,000 miles; it will be launched from heavy strategic bombers. Pentagon sources have said that an estimated $60 million will be spent on the project in the next fiscal year; the weapon is scheduled to enter service with Strategic Air Command in 1964.

● **Lockheed Aircraft Service** has converted ten Pan American Douglas DC-7Cs from passenger to all-cargo configuration at its Ontario, California overhaul base. The converted aircraft will carry payloads of up to 30,000 lb, have a useful capacity of 5,253 cu.ft. and a cruise speed of 300 m.p.h. The modification work consisted mainly in reinforcing the fuselage and replacing the old magnesium floor by a new aluminium floor. The latter is stressed for loads of up to 300 lb/sq.ft. The final stage of the conversion was the installation of new forward and rear cargo doors.



This flat four engine, the 4E.02, which is in production at Potez, has a take-off rating of 105 h.p. at 2,750 r.p.m.; cruise rating is 75 h.p. at 2,450 r.p.m. Potez manufactures another version of this engine, the 4E.00, with a take-off rating of 90 h.p. at 2,550 r.p.m.

● **The Lycoming T55-L-5 shaft turbine** has received U.S. Air Force and Army approval for uprating to 2,200 s.h.p. for military applications. The T55, which is installed in the Vertol YHC-1B *Chinook* Army helicopter, was previously rated at 1,940 s.h.p. Weight of the engine remains unchanged at 570 lb. Qualification tests are scheduled for August, 1960, and first deliveries to Vertol will start immediately afterwards. Uprating of the T55-L-5 was based on its previous 50-hour qualification and on recent tests, which demonstrated a power in excess of 2,500 s.h.p. Lycoming plans further power increases up to 2,700+ s.h.p.

● **Five Vertol YHC-1B Chinook turbine-powered helicopters** have been ordered to date by the U.S. Army, and flight operations of the first machine are scheduled to start during the first quarter of 1961. Powered by two Lycoming T-55-L-5 turbines, the YHC-1B will be able to carry up to three tons of payload on normal missions, and slightly less than eight tons on special missions; average cruising speed is claimed to be 130 knots. Cargo is loaded through the rear ramp-type door, 7.5 ft wide and 6.5 ft high, and through the forward cabin door. Unobstructed cabin space is 1,600 cu.ft. The YHC-1B can also be fitted to transport up to 33 fully-equipped combat troops or 24 litter patients. Further major design features are dual flight stability systems, including the Signal Corps-developed Universal Automatic Flight Control System and the Vertol-developed Stability Augmentation System. —Vertol has published the following specifications and performance data: Rotor diameter 59 ft; length with blades folded 51 ft; height 18 ft 6½ in.; gross weight 23,500 lb; max. speed (sea level) 152 knots; cruising speed 130 knots; max. sea level rate of climb 2,700 f.m.p.; hovering ceiling in ground effect 12,900 ft, and 6,000 ft out of ground effect and at 95°F; service ceiling 18,900 ft; range, with reserves, 200 n.m.

The "Jet Ramp" stairs built by Gebrüder Frech, Sissach, for Swissair's jet aircraft.

● **The Armstrong Whitworth AW.650 Argosy's** take-off weight has been increased from 82,000 to 88,000 lb. This will improve the payload over ranges of up to 1,800 miles. Max. payload has gone up from 27,000 to 28,000 lb, and the *Argosy* can now carry just under 27,000 lb for 600 miles and some 24,400 lb for 750 miles respectively at the British and American landing weight limits. The *Argosy's* most economic range has been raised from between 350 and 600 miles to between 600 and 750 miles. The aircraft can now carry a high-density load of 89 passengers at direct operating costs of about 1d per mile. Mean cruising speed is now quoted at 280 m.p.h., while max. cruising speeds of around 297 m.p.h. can be achieved.

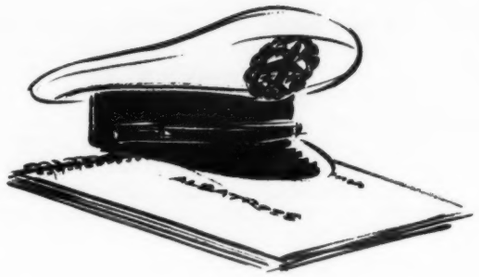
● **Ansett-ANA** completed the first 3,000-hour inspection of the airframes of its first two Lockheed *Electras* early last month. Inclusive of some progressive modifications, the work in each case took five days. Both airframes—the first two in the world to reach this point of operational testing—were found sound in every respect, with no sign of stress or cracking, despite the high utilization rate at which they have been operated in their first year of service.

● **Decca Navigator Company** has developed a navigation system to be known as the Decca "Omnitrac." The unit will provide push-button navigation between any two points regardless of the ground station location; left/right indication of track with distance to go; coupling with a suitable autopilot; and orthomorphic pictorial presentation. The heart of the system will reportedly be an entirely new miniature computer converting hyperbolic or other fixed lines into rectilinear coordinates. Omnitrac will use a basic master map of the world and convert doppler, Rho-Theta, Decca Radar, hyperbolic, inertial and other information into a single orthomorphic display with an automatic chart change unit. For the first time, therefore, a compact aid will be available to combine all the advantages of the various systems exactly as the pilot requires them. By making the presentation orthomorphic, all the problems of distortion are eradicated, and the coupling of the automatic pilot to give automatic navigation and flight represents a major development which will be invaluable for both subsonic and supersonic jet transports.

● **Canadair Ltd.**, of Montreal, has now finally concluded the $91.5 million contract with the Canadian Government for airframe construction and assembly of 200 Lockheed F-104 jet fighters for the Royal Canadian Air Force, and the Canadian Treasury Board has given its approval. This part of the CF-104 programme, estimated to cost a total $420 million in the next three to four years, may cost the Government more than planned. The Government is said to have decided to pay some tooling costs for production of component parts by Canadian firms to assure as large a Canadian content as possible. Canadair now expects to subcontract at least 60 percent of its share to Canadian companies and to spend about 10 percent to purchase off-the-shelf parts in the United States. Orenda Engines Ltd., of Malton, is to make the J79 jet engines under a $80 million contract, and Canadian Westinghouse, of Hamilton, will supply the armament control system under a $20 million contract.

● **Lockheed Aircraft Corporation's** contracts for the USAF's three military satellites, *Discoverer, Midas* and *Samos*—already valued at $230 million—have been boosted to $503 million by new contracts just negotiated for the current fiscal year (ending June 30th). Most of the work is already being executed at Lockheed Missile and Space Division's plant at Sunnyvale, Calif., under an earlier letter contract. Included in the new awards are $157 million for the *Samos* global surveillance satellite system, $60 million for the *Midas* missile detection system, and $56 million for the *Discoverer* space satellite programme.

● **The Cornell Aeronautical Laboratory** has developed a mobile test facility to obtain accurate aerodynamic data on experimental rotorcraft and ducted fan aircraft. The tractor-propelled apparatus, developed under contract to the U.S. Army, consists of a large flat-bed trailer which is towed at speeds of up to 60 m.p.h. A tower mounted on the trailer bed supports the rotorcraft during tests. A six-component balance system on top of the tower measures lift, drag and side forces, as well as yawing, rolling and pitching moments.



Notes from the Flight Deck

By Albatross

The Restricted Viewpoint

The Davies Report * which has all but grounded the Boeing 707—in Britain anyway—until structural modifications to improve handling qualities have been incorporated, need never have been written.

I'm not saying for a moment that the Air Registration Board's Chief Test Pilot, D. P. Davies, was wrong in writing it; on the contrary, I admire the courage with which he calmly announced in Seattle itself, the modifications he wanted made to the aeroplane before he was prepared to recommend a Certificate of Airworthiness.

What I am saying is that if the Boeing test pilots had been a little more aware of the men who were subsequently to fly the aircraft they were testing, Mr. Davies would never have been forced to demand the modifications he believes necessary.

Chief test pilots are extremely competent men. They would not hold the jobs they do unless they were. But being human, they are prone to become so familiar with the machines they have under their control that they can no longer put themselves in sympathy with the ordinary, averagely competent line pilot.

I have a car which suffered a slight mishap. As a result, it pulls slightly to the left. I don't notice the tendency any more, unless I consciously make a point of watching for it. I have adjusted myself to this idiosyncrasy. The man who services the car, however, tells me it's dangerous; and he's absolutely right. But because I have grown into the way of driving it as it is, I am perfectly safe; and yet, this in no way excuses me from having the fault eliminated !

Tex Johnson and his team adjusted themselves to the 707's idiosyncrasies early on, but in so doing lost the *common touch*. In fact, after the backlog of experience they had built up testing hundreds upon hundreds of B-47s and B-52s, it is more than likely that they were never in sympathy with the common pilot plying the commercial routes anyway.

But they're in good company. H. G. Hazelden, the big Chief Test Pilot for Handley Page, who is reputed to crush walnuts between his thumb and forefinger, was apparently surprised when some ordinary pilots complained that flying the *Herald* left them physically exhausted.

What then is the answer to all this ? Simply picking one or two average pilots from an airline —experienced, senior men will not do—and fitting them into the early stages of a flight test programme for two or three months. If the aircraft has any hazardous handling bugs hidden by familiarity to the company test pilots, they will soon show up when the line pilots take over the controls.

A repeat pilot posting at a later stage of the flight test programme would be desirable to ensure that the aircraft was safe and sound in the hands of the average aircraft captain accustomed to handling something quite different.

It was not the Davies Report alone which prompted these comments ; they were triggered by some quotes of Captain E. R. Watson of Eastern Airlines in the ALPA magazine. He wrote: "Undoubtedly the most important factors to be considered by the turbine powered aircraft pilot are speed and aircraft performance. As one airline pilot who has checked out on jets said, this was the first aircraft he had flown where he got a good view of both ends of the runway during take-off."

"Another pilot said that for the first time he was able to read the sign on the ILS shack at the other end of the runway. It says KEEP OUT—and this is just what he hopes to do !"

Command or Control

The difficulties of transition from instruments to visual references outside an aircraft during bad weather approaches have led to the institution of the monitored approach—one pilot flying the aircraft down the glide-path on the panel until the second makes the visual contact with the ground and takes over for the landing.

Resisted at first, the practice has now found wide acceptance, which isn't surprising when you consider how much it eases the strain imposed on a pilot trying to "commute" visually between two very different sets of references at the most critical moment of a flight.

A further step has now been suggested, however, and the basic principle underlying it is simply that of relieving the aircraft commander of the responsibility for manipulating the controls so that he may double-check every action carried out in the control cabin which might affect the safety of the aircraft, and have ample time for crew coordination and forward planning.

The reasoning behind this is sound enough. The modern flight deck is such a nightmare of selector switches, and manœuvring procedures are so exacting—particularly in bad weather—that at a critical stage of flight an aircraft captain narrows his scope of thinking to the point where the wider "commander view" ceases to exist—a time when the exercise of the widest degree of responsibility is of paramount importance.

The *Commander Concept* (what a horrid expression !) would introduce, it is claimed, "a system of cabin management which would allow the captain to exercise his duties as a commander properly. By this means he would be able to devote the necessary time to achieve the safest possible operational control of his aircraft, and at the same time exercise an adequate supervisory control over his pilots and their actions."

There are many difficulties ahead for this idea. Delegating the responsibilities of monitoring the men at the controls to a third pilot has been rightly criticized on the grounds that a junior officer would hesitate to correct his seniors. But what of the commander monitoring his juniors from the " throne " behind them ? Will he have essential confidence in their ability to handle the aircraft, or will he be itching to take over, like the motorist in the back seat pressing on a brake that isn't there ? These are points that need careful attention.

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My own views on how it can be made to work are simple enough ! Out of three pilots assigned to an aircraft, two must be of equivalent experience and seniority and they must share the command " throne " and the left hand seat on roster basis. Only then will it work, human nature being what it is. ↔

* After completing the test evaluation of the first 707 for BOAC in January 1960, the ARB requested that certain modifications be incorporated prior to final ARB evaluation. These improvements included the incorporation of a 35-inch extension to the vertical fin, full-power boost on the rudder, changes to the yaw damper and the inclusion of a small ventral fin.

International Disharmony Over Navigational Aids

By H.H.B. Capes, Decca Navigator Ltd., London

The article in the March issue of Interavia entitled "International Cooperation in Airspace Control" purports to show that the history of VOR/DMET is an example of "International Cooperation and Solidarity in the Field of Aviation." This statement requires some qualification.

The ICAO Council is about to meet to consider the results of the Special COM/OPS/RAC Meeting in Montreal of February 1959, the most important of which was a recommendation that ICAO should adopt the distance measuring element of the TACAN system as a standard navigational aid complementary to the existing standard, VOR, in operational and Air Traffic Control conditions where VOR alone would not provide sufficient navigational precision. It has to consider further the adoption of this form of DME until 1975. A critical phase of an international controversy which has been fiercely fought on many fronts and in many international conferences is thus approaching a climax.

It is doubtful whether any contemporary civil aviation issue has resulted in so much international debate and downright argument as the navaid question. The issue is broadly between, on the one hand, line of sight Rho-Theta systems whereby the aircraft's distance and bearing are indicated from ground beacons, and on the other hand, non-line of sight hyperbolic systems associated with a pictorial display in the cockpit whereby omni-directional navigational coverage is provided over an area, and the position of the aircraft is indicated pictorially and continuously at all times. The VOR/DMET system falls in the former category and the Decca system in the latter.

After prolonged international discussion, VOR was eventually accepted unanimously as a suitable aid for standardization for general navigational guidance and control except for those busy traffic areas where a far greater accuracy and flexibility is required for the efficient functioning of Air Traffic Control. This then is the crucial point. The protagonists of both types of system agree that VOR alone is inadequate in these areas. The question is: what should be added to VOR-DMET or Decca?

One would suppose that a question of this character could be resolved comparatively easily by simply drawing up a list of the operational requirements common to all the critical areas and then comparing each system with these to see which most nearly satisfied them. The ill-fated ICAO Special Meeting of February 1959 was intended to do this. It failed to do so. The reason for this was obvious, and this is apparent (though clearly not intended to be a revelation) from General Piollet's article.

The United States, which disposes of by far the greatest financial interest in the civil aviation market, was committed to an existing VOR network, and by virtue of the pressure of the military interests in the Tacan system, to the outlay of vast capital expenditure on the DME portion of Tacan as the second component of the traditional U.S. Rho-Theta concept. The United States therefore could obviously not take an objective look at the navaid situation. If the decision went against them, fantastic investments of capital would be lost. Many countries, for reasons which are equally obvious, followed the United States lead. CEAC, a NATO body, came into line—although there is in Europe a DMET frequency problem of great magnitude which has yet to be solved.

The United Kingdom, supporting the rival Decca system, is the leader of the opposite camp. Here there are no such financial commitments to dictate policy, and indeed we find that the U.K., supported by some Commonwealth countries and the International Federation of Air Line Pilots Associations (representing incidentally a body with a very close interest in this matter) was prepared at the 1959 ICAO Meeting, and still is prepared, to submit the rival systems to a straightforward matching of each against the operational requirements—when these are defined.

Is it too much to hope that, even at this late hour, this simple exercise should be undertaken? The ICAO Council has a golden opportunity to inject a calm, objective note into this sordid and undignified international wrangle by themselves specifying that no decision will be taken on the navaid question until a competent, independent and quite impartial body has carried out this exercise, completely detached from military or civil, financial or political partisanship.

Manhattan's Second Heliport

The Port of New York Authority is building a new heliport on the East River, just above the Battery, under terms of a lease agreement between the Authority and the New York City Department of Marine and Aviation. The site (shown here in cross hatch) includes existing Pier 6 and lands under water between Piers 5 and 8. A first phase heliport, to cost an estimated $165,000, will be ready for operation by about the end of the year. The new heliport will be able to provide direct helicopter service between downtown Manhattan and La Guardia, New York International and Newark airports.

Book Reviews

Essais en vol. — Performances et qualités de vol. By J. Renaudie. —Dunod, Paris, 1960 (French; 2 volumes: 190 and 164 pages with many illustrations; paper backs; both volumes NF 39).

Each year sees an increase in the demands made on the pilots, engineers and laboratory technicians who have to test new aircraft. The publication of the present two-volume work on flight tests is therefore very timely. The first volume discusses the theory and practice of calibrating aircraft measuring equipment, and also the calculation of flight performance; it includes detailed descriptions of test procedures and numerical evaluations of the results recorded. The second volume is devoted to flying qualities and deals with stability (roll and pitch, static and dynamic), controllability (effectiveness of ailerons and horizontal tailplane, actuation of control surfaces, stalling and slow flight), and flight with asymmetrical thrust.

The clarity with which this complicated subject has been presented is highly commendable. The author, Professor at the Ecole du Personnel Navigant d'Essais, has given us a work which should be of the greatest value not only to all those concerned with flight tests, but to readers who wish to keep their knowledge of flight techniques up to date. L.M.C.

Lexikon der Hochfrequenz-, Nachrichten- und Elektrotechnik, Vol. 4, R-Z. — Edited by Curt Rint. — Porta-Verlag, Munich, and Verlag Technik, Berlin, 1959 (German-English-French-Russian; 852 pages; price DM 28.75).

With the publication of the fourth volume, which contains 4,187 words and their definitions, this excellent work—the first three volumes of which have already been reviewed in these pages—is now practically complete. The four volumes together number 3,363 pages, with more than 2,000 illustrations and many tables. Altogether some 25,000 terms connected with electrical engineering and related subjects are defined. The final, so-called dictionary volume (Vol. 5) is due to appear in a few months time; it will list all the main terms used in the work alphabetically in English, French and Russian, in each case with a reference to the German definitions in the main volumes. It is also planned to bring out a supplement at the end of 1961 containing all the new terms which have appeared since first publication. However, this lexicon is already an indispensable work of reference for engineers, teachers, students, technical writers and all others in any way concerned with electrical engineering. It contains such a wealth of information that it can readily replace a library of many volumes. V. L.

Ballistik. — By R. E. Kutterer. — Friedr. Vieweg & Sohn, Brunswick, 1959 (3rd, revised edition, 304 pages with 176 drawings and illustrations, 21 tables; price DM 38.00).

Recent years have seen such an unprecedented development in rockets, both guided and unguided, that the field of "conventional" ballistics has been greatly expanded. At the same time, this process has gone hand in hand with developments in measuring techniques which are of direct interest to engineers and physicists in other branches of science.

The present book discusses, among other topics, the trajectory of a shell in a vacuum and in the airspace, measuring problems, the mechanics of gases and applications to problems of ballistics, the fundamentals of internal ballistics, special questions of internal ballistics, and the question of improving the performance of modern weapons. Part 3 deals with the internal and external ballistics of rockets. The main characteristics of this work are clarity, simplicity and understandability, all on a strictly scientific basis. V. L.

Introduction to Rocket Technology. — By V. I. Feodosiev and G. B. Siniarev. Translated from the Russian by S. N. Samburoff. Academic Press, New York, 1959. English 344 pages; illustrated and indexed; price $9.50.

As the subject of Rocket Technology draws upon so many engineering sciences, the difficulties in writing a suitable introductory text book are manifold. The newcomer to the science should already possess a broad preparation in a number of engineering fields at the outset. With this preliminary qualification in mind the authors have produced a book which is designed for the reader with a general background in physics, chemistry and the fundamentals of higher mathematics. For the reader possessing this basic technical background this book will be of considerable service. The sections range from the basic relationships in the Theory of Reactive Motion to types of reaction motors, rocket fuels, processes of combustion, gas flows and rocket steering and stabilization. Each topic is treated separately and thoroughly and the subject matter is handled solely as an engineering problem. Little reference is made to military applications of rockets or their use as a military science, and reference is only made to particular types to emphasize a feature of construction. This book will be a valuable addition to the bookshelf of any engineer who is entering this complex science. E. K. B.

Seeing the Earth from Space. — By Irving Adler. — The John Day Company, New York, 1959 (English; 159 pages; illustrated).

The author has here added another volume to his series of popular scientific books, designed this time to relate what new information on our planet American and Russian scientists have obtained with the aid of satellites. The book describes in very simple language something about the true shape of the earth, its field of gravity and magnetism, the atmosphere, ionosphere, cosmic rays and many other subjects. . . to enable the ordinary reader to "see the earth from space" as the satellites are doing. The final chapter gives a glimpse of future space research plans. The book is well illustrated with photographs and drawings. V. L.

Flugsicherungstechnik II (Fernmeldeanlagen). — By Dr.-Ing. K. Bärner.—Volume 6 of the "Bücher der Luftfahrtpraxis" series; edited by Dr.-Ing. H. J. Zetzmann. —Hanns Reich Verlag, Munich, 1959 (German; 310 pages with 234 illustrations, paper back; price DM 18.80).

Volume II of "Flugsicherungstechnik" describes not only navigation procedures, but also communications systems and equipment of interest in air traffic control; the chapter entitled "Leitungen und Antennen" serves as an aid to the understanding of Volume I. Other subjects dealt with are voice radio, radio links, wire-type telecommunications, a survey of the future tasks of air traffic control, and transfer systems; the volume also contains a bibliography. V. L.

Jahrhundert der Raketen. — By Heinz Gartmann. — Verlag Paul Müller, Munich (German; 320 pages; 80 drawings; 32 photographic plates; cloth-bound; price DM 12.—).

This new book by Heinz Gartmann, the well-known aviation and astronautical writer, is the ninth in the series "Die Welt von Heute," published by Verlag Paul Müller. The author has the gift of being able to present his subject vividly and simply for the non-technical reader. He deals with nearly all aspects of rocketry, from the fantasies of past centuries through the present state of the art to visions of the future. The text is supplemented by clear drawings, high-quality photographs, sound literary references and succinct marginal notes. The book should have great appeal to young people, who, we hope, may live to see the development of peaceful space travel. De.

ECON—Weltraum ABC.—Edited by Heinz Gartmann.—Econ Verlag GmbH, Düsseldorf (German; 256 pages; sketches, diagrams; cloth-bound; price DM 6.80).

Heinz Gartmann, who belongs to the first generation of German rocket scientists and astronautics journalists, has already had two volumes published by Econ Verlag: "Träumer, Forscher, Konstrukteure" and "Stärker als die Technik." He has now brought out a glossary of about 800 terms to make the complex field of astronautics more intelligible to the layman. It contains items dealing with such subjects as nuclear propulsion, Cape Canaveral, weightlessness, the cost of space exploration, lunar probes, rocket propellants, space medicine and space stations. The author devotes particular attention to concise biographies of rocket and space experts of all nations, and the work contains numerous literary references from Newton to Wernher von Braun. This inexpensive reference work is highly recommended. He.

IAL Handbook of Aircraft Data 1959/60.—Compiled by G. R. Stroud. International Aeradio Limited, Southall, Middlesex (English; 47 pages).

Although this compact reference work is intended mainly for airport authorities, it should be of good service to all concerned with aviation. It lists the dimensions, weights, performance and engine data for aircraft from all over the world which are either in service or due to be placed in service within the next twelve months; these include airliners, business, agricultural and multi-purpose aircraft and the major military transports. All data are given in English and metric measures. There is also a complete list of international identification marks. De.

Famous Airships of the World. By Captain J. A. Sinclair. Illustrated by A. Eisner. Frederick Muller Limited, London, 1959 (English; 144 pages; 12 photographic plates + many drawings in the text; price 9s. 6d.).

A straightforward story of airships since the early beginnings up to the present day, with detailed treatment of such famous names as the Italia, R.100 and R.101, Shenandoah, Graf Zeppelin and Hindenburg, Akron and Graf Zeppelin II. The book is clearly presented and well illustrated, and forms an admirable record of the many useful tasks which have been performed by airships in war and peace. St.

Sent Flying.—The Autobiography of Bill Pegg.—Macdonald, London, 1959 (English; 236 pages; many photographs; plastic-bound; price 21s.).

A British air ace and Chief Test Pilot of the Bristol Aeroplane Company, whose name will always be linked with the *Brabazon*—the "flying skyscraper"—and the *Britannia*, gives, not without self-criticism, a humorous and vivid account of 35 years' flying. Although Bill Pegg's life has had its fair share of "thrills and spills," he can chalk up only two crash-landings caused by errors in judgment: while still a pupil he "pranged" a trainer, and years later—when he was Chief Test Pilot at Bristol—he smashed up a five-seat helicopter. In other words, Bill Pegg, while sparing no personal effort, has always avoided unnecessary risks . . . Incidentally, he has had only one bank overdraft in his life, and that was when he was still a young officer in the RAF with £2.12.4 pay a week.

Bill Pegg's activities, ranging from the days of "string-and-sealing-wax" contraptions to the era of 100-passenger turbine aircraft, will be of interest to all who consider the human factor to be the most important in aviation. He.

Complete Conversion Tables—American, English and Metric Measures. By Francis Cusset. Blondel La Rougery, Paris, 1959 (English, French, German; 230 pages).

It is superfluous to demonstrate the usefulness of conversion tables when this is an established fact. The particular merit of those compiled by Francis Cusset lies in their completeness: they contain tables of length, surface, volume, capacity, flow, mass, force, energy, power, pressure, temperature, thermal units, moments of inertia of sections, moduli of sections, and currencies. Summaries and chapter and page headings are in three languages, and the book's spiral binding makes it handy to use. This is a work essential to all those, engineers, technicians and specialists of all kinds, who have to convert measures. Ka.

Kameradschaft der Lüfte. — Translated from the English "Wing Leader," by James E. Johnson. Translator: Herbert Zuerl.—Albert Müller Verlag AG, Rüschlikon-Zurich and Stuttgart (German; 315 pages; 9 photographs).

A thrilling account of a fighter pilot's experiences during World War II, from the Battle of Britain to the last days of the war. Contains an appendix with brief notes on British, American and German combat aircraft. De.

The New Private Pilot.—Edited by John Dohm.—Pan American Navigation Service, North Hollywood, Calif. 1959 (English; 301 pages; paperback; price $4.95).

This new Zweng Manual contains all the information necessary to obtain a U.S. private pilot's licence. Among the subjects dealt with in the ten concise and readable chapters are the theory of airframes and powerplants, meteorology and weather recognition, radio operation and radio navigation. The handbook also gives practical information on what to do in special cases. There are 87 specimen questions of the type set in the U.S. private pilot's written examination, together with their answers. A pocket at the back contains extracts from the Civil Air Regulations and weather and navigation maps. De.

Der Weltenraum in Menschenhand.—Edited by H. Bolewski and H. Gröttrup.—Kreuz-Verlag, Stuttgart, 1959 (German; 283 pages; cloth-bound; price DM 14.80).

Unlike most writers, the two editors, Dr. Hans Bolewski and Dipl.-Ing. Helmut Gröttrup, have let the facts speak for themselves in depicting the significance of astronautics. Experts such as Wernher von Braun, Prince Welf Heinrich of Hanover, Fritz Erler, Sir Stephen King-Hall, Max Born and others discuss technical, medical, legal, political, military and religious problems. Most of the essays are based on papers read at meetings of the Loccum Evangelical Academy. De.

Great Aircraft, By W/C Norman Macmillan, O.B.E., M.C., A.F.C. London, G. Bell & Sons Ltd. 1960. (English, 304 pages, 16 photos, price 21 shillings.)

In the publisher's note on the dust jacket of this book is the comment that this is the twenty-first volume from the author's pen, and that W/C Macmillan believes it to be his best to date. It is a justifiable opinion, for the book is both well written and informative and avoids the flow of superlatives which so often appear in such a work. The author has chosen ten aircraft, both military and civil, commencing logically enough with the Wright *Flyer*, and discusses their claims to fame. Each of the aircraft selected represents a step forward in aviation history either in terms of design or performance and each has left his mark on its successors. The story is not merely a list of triumphs, for some of the aircraft which finally became great started in unpromising fashions. A lifetime's association with aviation and active flying is ample qualification for the author's ability to make this selection, and a reader's complaint could only be based on grounds of omission. Opinion will always differ on the constitution of a " great aircraft, " but this list has been made on the qualities of the machines themselves and not on the exploits of the men who flew them. One critical word in conclusion—W/C Macmillan will needlessly confuse the draughtsmen of English Electric by telling them that the muddy stream which borders their aerodrome is the Manchester Ship Canal. E.K.B.

Famous Bombers of the Second World War, by William Green, London, MacDonald 1959. (English, 132 pages. 200 photos, illustrated by G. W. Hermann, price 21 shillings.)

In one word—excellent. Mr. Green has previously assembled a similar record of World War II fighters, and this volume of the famous bombers of the era is a worthy companion. In his introduction the author expresses his sympathy for those readers who do not find their personal choice of aircraft referred to in the book, but promises a second volume which may remedy some omissions. Twelve aircraft are discussed exhaustively in this first edition. The number is made up of four German aircraft, four American, three British and one Italian. The potential reader can make his own list in these proportions and then buy the book to see if his list and opinions compare with the author's.

The book is lavishly illustrated with both photographs and also excellent detail drawings by G. W. Heumann, and the text indicates the vast amount of exhaustive research and selection that has gone into the compilation. In brief it is a book which makes a serious contribution to military aviation history, and at the same time will be of interest to the reader who perhaps has some personal association with the aircraft it contains. The combination of technical and historical detail is neatly blended and the reader is not confused or even bored by a long recapitulation of Mark numbers, variants and dates, unrelieved by more easily digestible detail.

E.K.B.

Books received

Boeing 707, by Martin Caidin. Ballantine Books, New York, 1959, English, 213 pages, 16 photo pages, 34 drawings.

Die Weltraumfahrt hat begonnen — Vom ersten Satelliten bis zur Mondreise, by Karl Schütte. Herder-Bücherei, Freiburg im Breisgau, 1958, German, 173 pages, 40 illustrations, 19 tables.

Moon Base, by William Nephew and Michael Chester. G. P. Putnam's Sons, New York, 1959, English, 72 pages, 19 drawings.

Rockets of the Navy, by Eric Bergaust. G. P. Putnam's Sons, New York, 1959, English, 48 pages, 44 illustrations.

Satellites and Space Probes, by Eric Bergaust. G. P. Putnam's Sons, New York, 1959, English, 48 pages, 52 illustrations.

Our Space Age Jets, by C. B. Colby. Coward-McCann, Inc., New York, English, 48 pages, 50 illustrations, 21 drawings.

Die Kräfteermittelung in dünnwandigen Blechkonstruktionen, by A. F. Feofanow. Herbert Cram, Berlin, 1958, German, 220 pages.

Met Raketten de Wereldruimte in, by Hugo Hooftman. Van Holkema & Warendorf N. V., Amsterdam, 1959, Dutch, 96 pages, 16 photo pages.

Publications scientifiques et techniques du Ministère de l'Air : distributed by: Service de Documentation et d'Information Technique de l'Aéronautique, Paris, 1959.

No. B.S.T.123: Eléments des calculs d'interpolation, by Donatien Cot.

No. B.S.T. 123: Mécanisme de la déviation des jets propulsifs, by M. Kadosch.

No. 353: Sur quelques problèmes posés par l'expérimentation en soufflerie aérodynamique, by André Martinot-Lagarde.

No. 354: Construction et étalonnage d'une soufflerie à gaz très rarefié, by F. Marcel Devienne, Georges M. Forestier, André F. Roustan.

No. 355: Explorations de la couche limite, en turbulence naturelle et en turbulence provoquée, dans le cas d'un écoulement supersonique le long d'une plaque plane, by Jean-François Dorand.

No. 356: Doublet d'hélices coaxiales—hélice unique, by Jean Cristescu.

No. N.T. 84: Méthodes topologiques appliquées à l'électronique, by Lefteri Sideriades.

No. N.T. 85: Séminaire d'aérothermique de la faculté des sciences de Paris, by Edmond A. Brun.

No. N.T. 86: Nébulogranulomètre pour l'étude des brouillards naturels et artificiels, by Albert Arnulf, Jean Bricard, Claude Véret and Robert Burtin.

Deutsche Studiengemeinschaft Hubschrauber E.V., Stuttgart:

Report 38: Wirtschaftlichkeit des Hubschraubers — Einfluss der Zuladungskapazität und Fluggeschwindigkeit auf die Wirtschaftlichkeit von Hubschraubern, by W. Lambert, E. Skubinna, H. Brusberg, Verlag Flugtechnik, Stuttgart, September 1959.

Berichte der Deutschen Versuchsanstalt für Luftfahrt e.V. : issued by the Zentrale für Wissenschaftliches Berichtwesen der DVL, Mülheim, Ruhr; Westdeutscher Verlag, Cologne and Opladen, 1959:

Report No. 63: Flugvermessung der Empfangscharakteristik einer 75-MHz-Einflugzeichen-Bordantenne, by A. R. Wendlinger and M. Raab (Price DM 14.70).

Report No. 93: Die Theorie der Verdampfung und Verbrennung des einzelnen Kraftstofftropfens, by G. Rüping (Price DM 26.20).

Report No. 103: Berechnung von kugelsymmetrischen Verdichtungsstössen mittels Charakteristikenverfahren, by F. Bartlmä (Price DM 13.10).

Forschungsberichte des Wirtschafts- und Verkehrsministeriums Nordrhein-Westfalen : edited by Staatssekretär Prof. Dr. h.c. E.h. Leo Brandt, Westdeutscher Verlag, Cologne and Opladen, 1958:

Report No. 644: Untersuchung einiger mechanischer Eigenschaften von Sinteraluminium S.A.P. und S.A.P.-Avional, by Prof. Dr.-Ing. Franz Bollenrath (Price DM 8.10).

Report No. 659: Die Zementation des Bleis auf Aluminiumoberflächen beim chemischen Glänzen nach dem Erftwerk-Verfahren mit Hilfe des radioaktiven Isotops Pb-210, by Prof. Dr.-Ing. Helmut Winterhager and Dipl.-Ing. Klaus Reiprich (Price DM 12.10).

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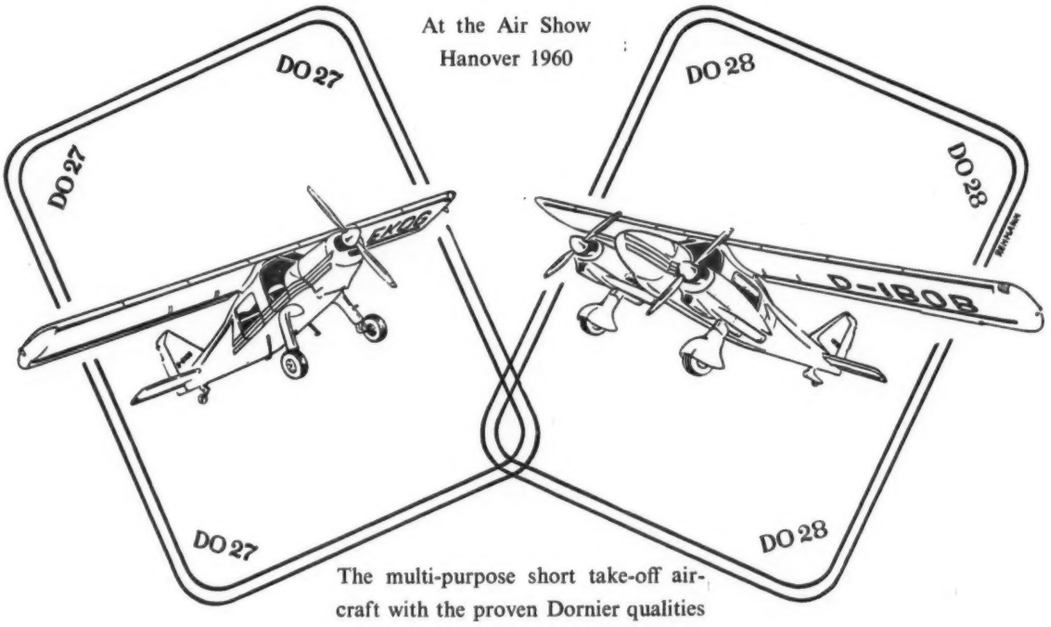

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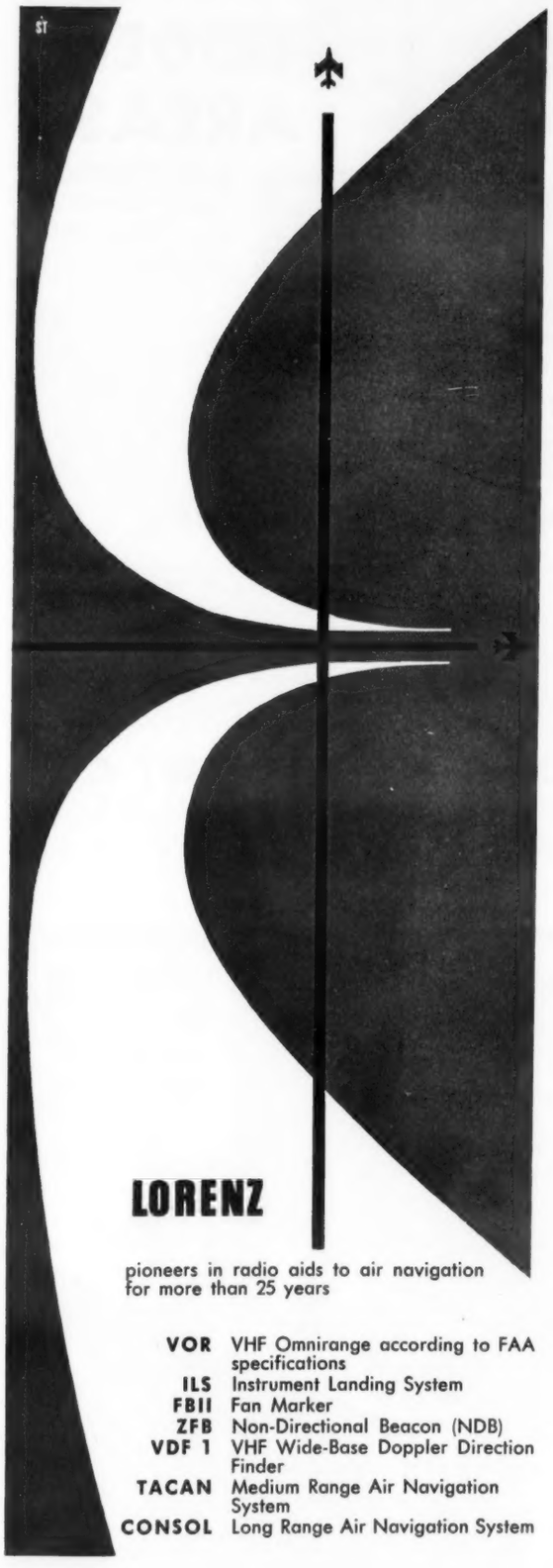

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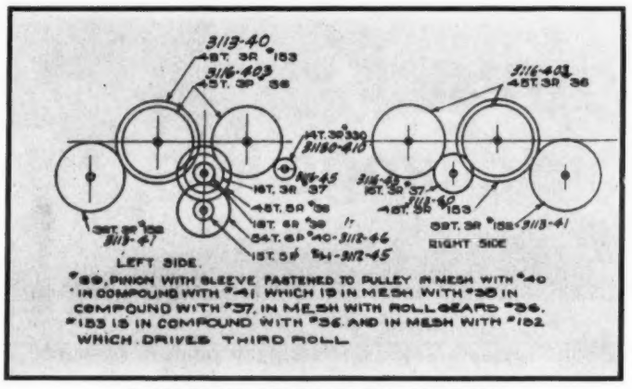
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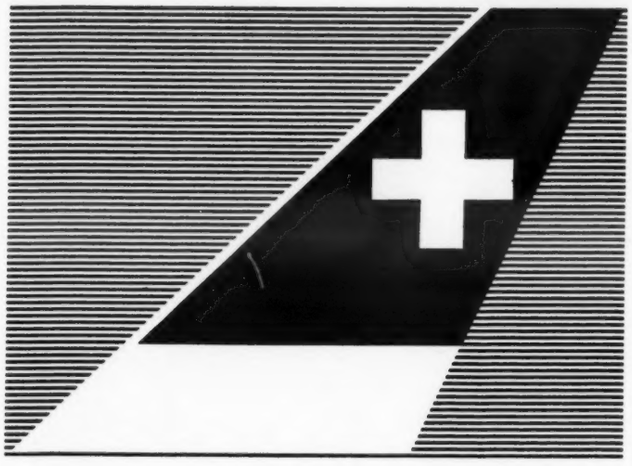

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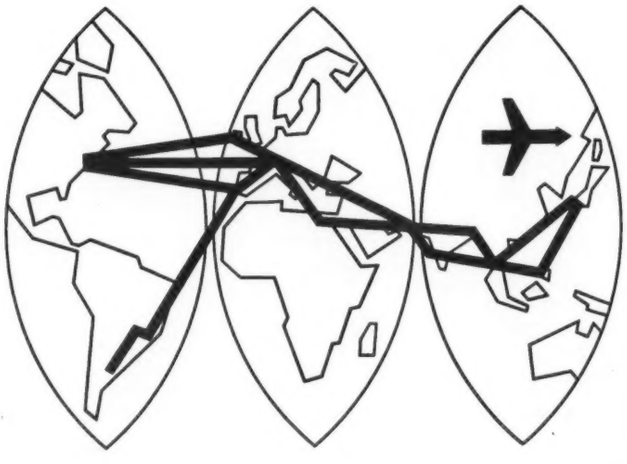

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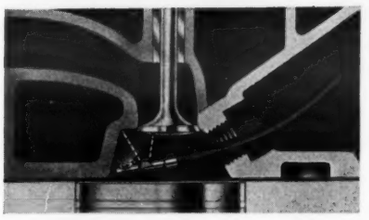

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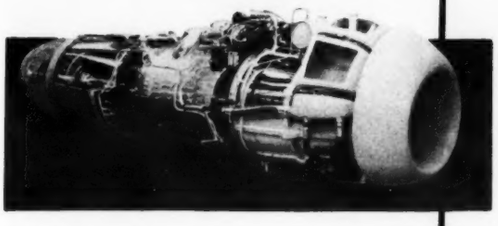

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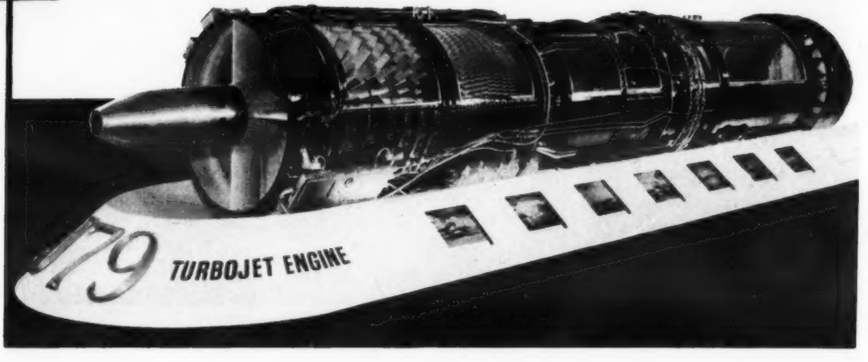

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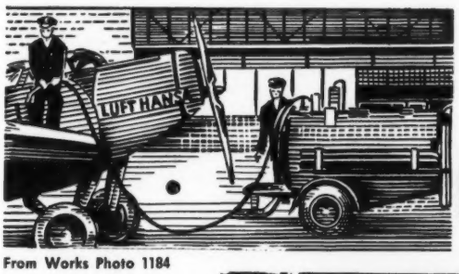

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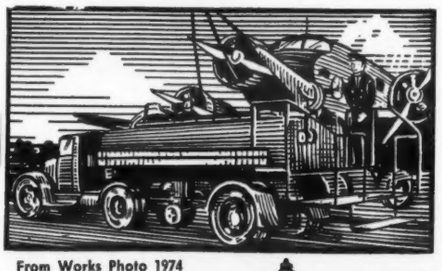

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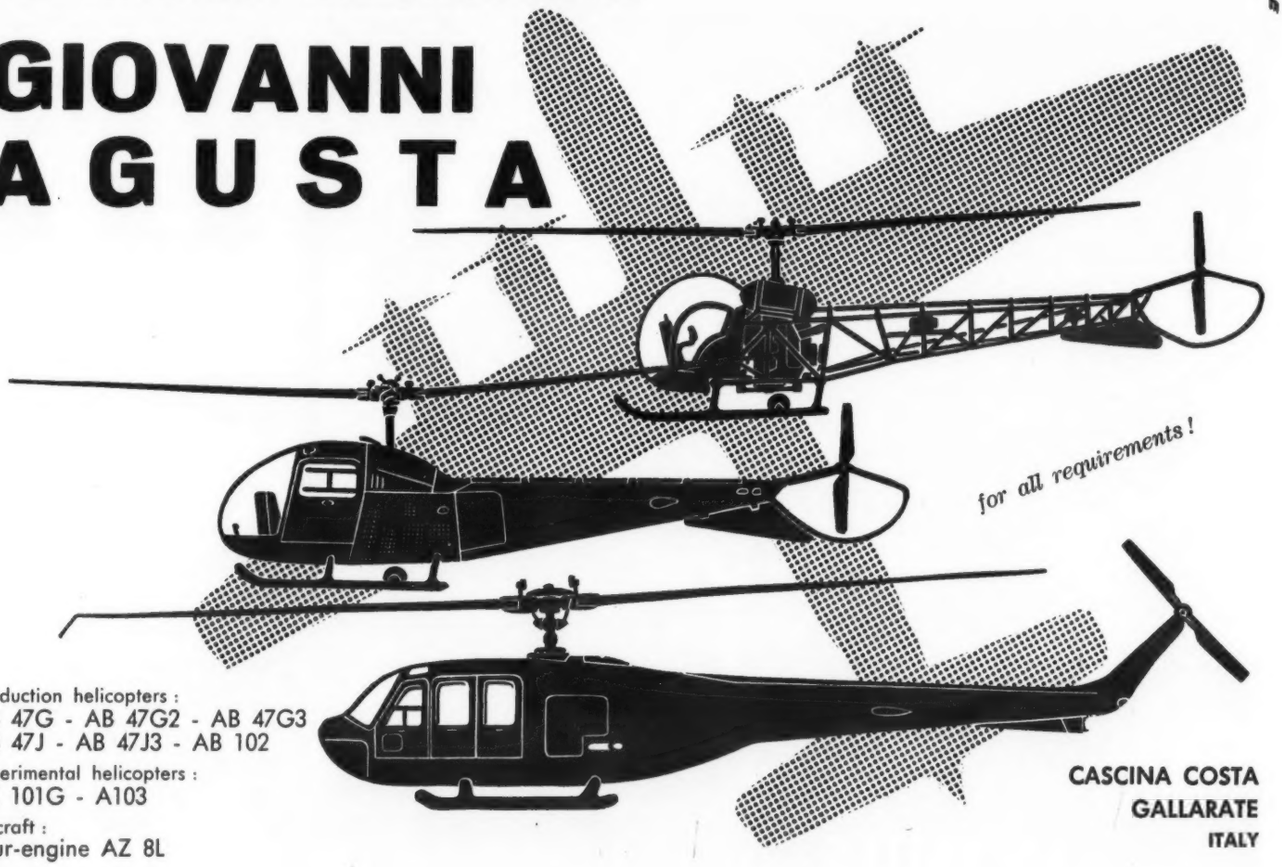

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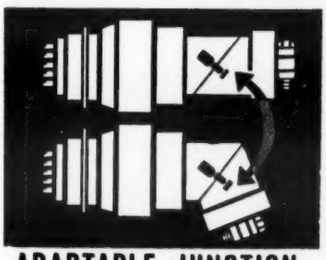

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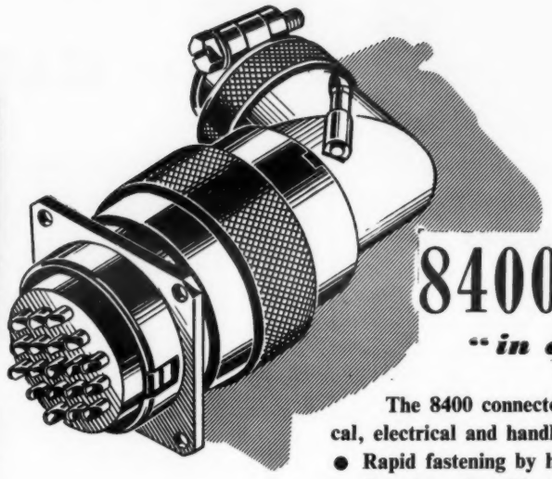

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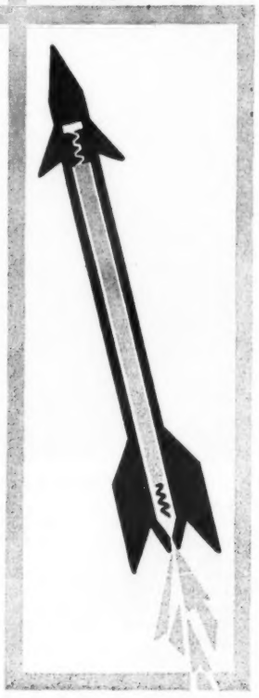

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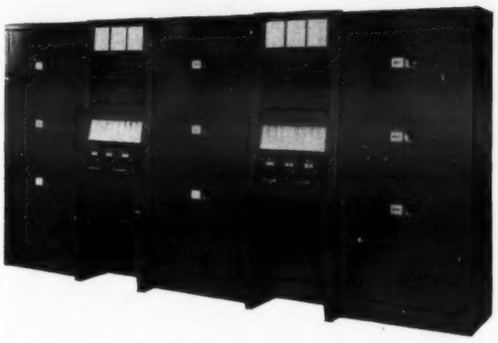

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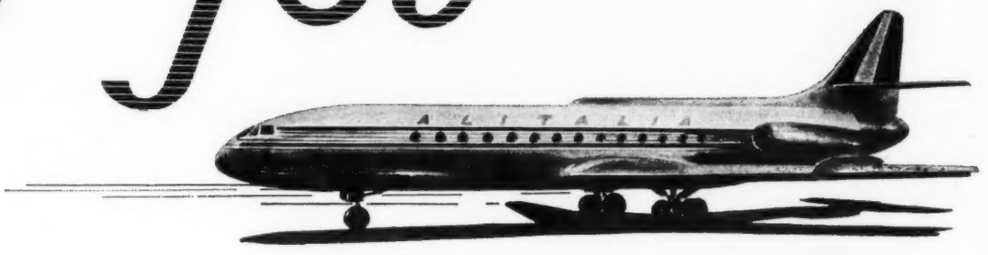

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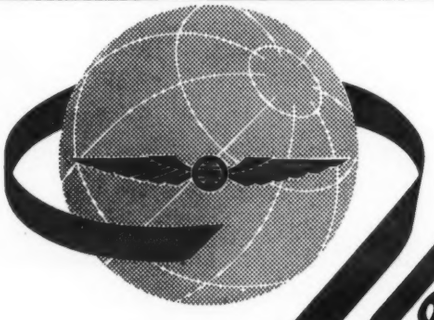

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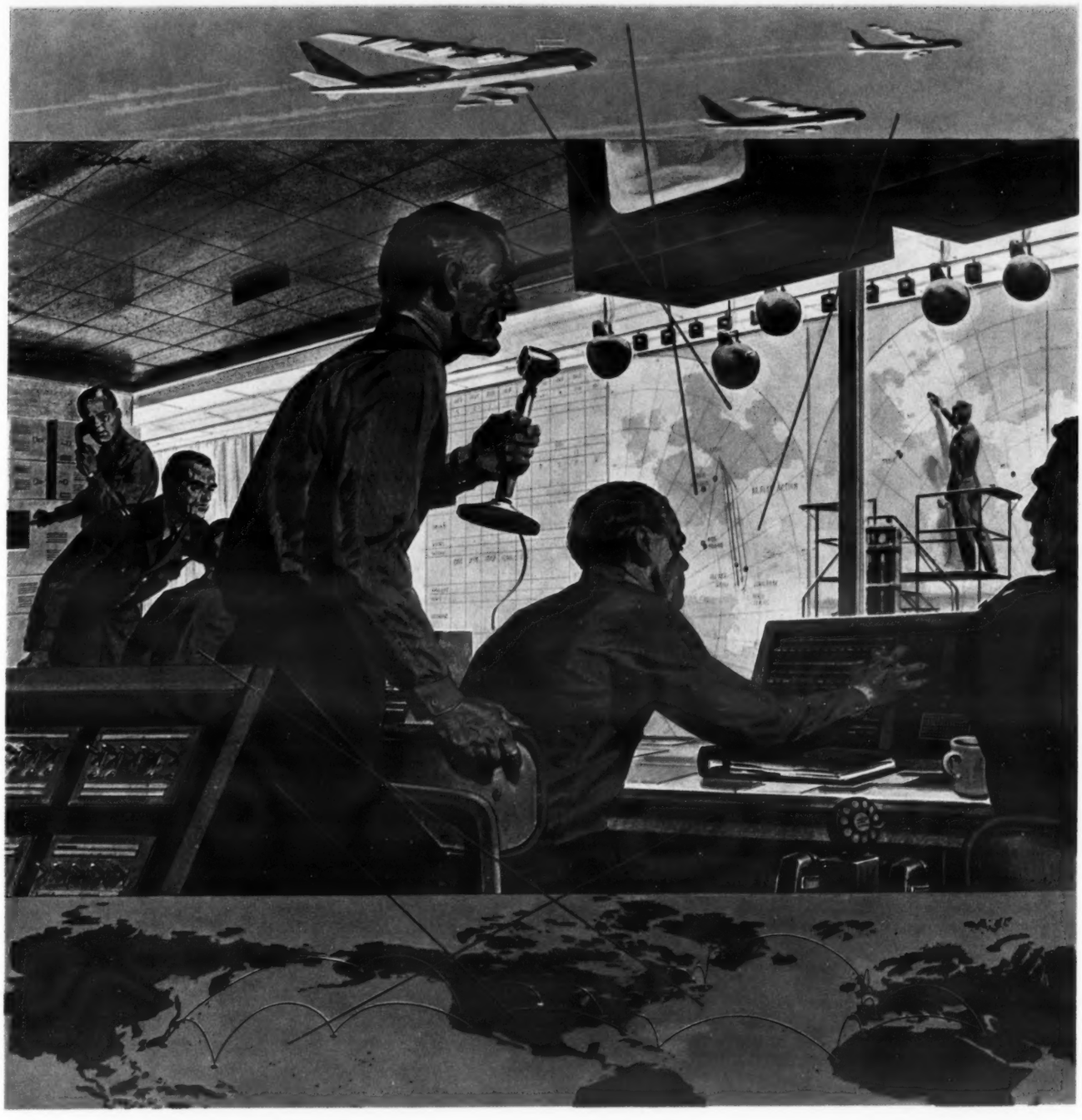

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